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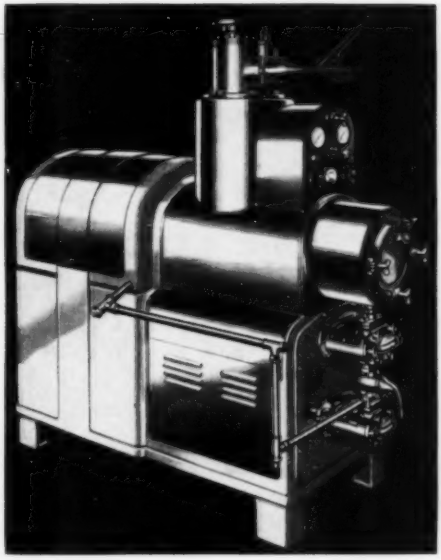

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OBSERVATIONS ON THE FREEZING OF MILK AND CREAM II. THE DESTRUCTION OF THE FAT EMULSION IN FROZEN CREAM*

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Cream which has been partially frozen or frozen to apparent solidity for the purpose of storage, almost invariably shows evidence, upon thawing, of a partial destruction of the fat emulsion. This phenomenon has been noted and studied by several investigators (1, 2, 3, 4). Recently Webb and Hall (5) have shown this separation of "free fat" to increase with the fat content of the cream and suggest that it is dependent on several factors, the most important being, "the freezing point of the aqueous phase, the protection afforded the emulsified fat by adsorbed protein, and the size of the fat globules themselves." Sommer (6) atributes the breakdown of the fat emulsion to the destabilization of the protein adsorption film, around the fat globules, brought about by freezing. However, it has been shown that the protein of frozen milk and cream is not appreciably affected until after a considerable interval of holding in the frozen condition (1, 5) whereas the fat emulsion is immediately affected (1, 3, 5). Mack (7), Price (8), and also Webb and Hall have found that additions of sugar to cream before freezing markedly decrease the amount of oiling off of the fat after thawing.

EXPERIMENTAL

Methods

To study the effect of freezing upon the destruction, of the fat emulsion, samples of commercially pasteurized cream containing 25 and 40 per cent fat and 40 per cent of fat plus 10 per cent of sucrose, respectively, were frozen in two-quart tin containers, without agitation, in still air, at –23° to –28° C. until congealed to varying degrees. Approximately 9–10

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hours were required to freeze to apparent solidity under these conditions. After freezing the samples were thawed in a water bath held at 10° C. They were not stirred until all the ice was melted and then the sample was poured through a 30-mesh screen. The material on the screen was weighed and analyzed for fat by a modified Babcock method. The amount of fat thrown out of emulsion by freezing was calculated as the per cent of the total fat in the sample.

Samples were taken from the freezing room when the amount of freezing (determined as explained in the previous paper (9) varied from 10 per cent to apparent solidity.

To study the internal pressure developed in the samples of cream during freezing, a manometer arrangement was set up. This consisted of a rubber bulb which was placed in the sample at the point which previous experiment had indicated to congeal last. The bulb was filled with alcohol and was connected to the U tube of the manometer by glass tubing. The tubing was filled with alcohol from the bulb to the top of the mercury column of the U tube. The relative pressure developed in the samples was read in millimeters, being the difference in level of the mercury in the two sections of the U tube.

The Effect of the Degree of Freezing on the Fat Emulsion

Samples of 25 per cent cream, 40 per cent cream and 40 per cent cream containing 10 per cent of sucrose were frozen to various degrees and the

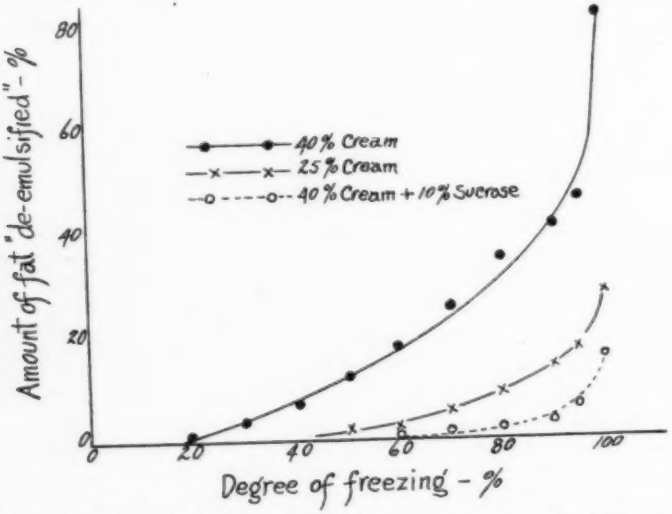

FIG. 1. The effect of the degree of freezing upon the amount of fat thrown out of emulsion in cream.

amount of fat thrown out of emulsion determined. It was found that the amount (expressed as percentage of the total fat) increased with the degree of freezing and with the fat content of the cream. It was also noted that the fat of the cream containing sucrose was less affected than where sucrose was not present. The average data obtained from six to eight trials with each product are presented in Figure 1. Apparently the fat emulsion was not affected appreciably until freezing had progressed to the point where 50 per cent of the 40 per cent cream was congealed, 80 per cent of the 25 per cent cream was frozen and until the 40 per cent cream containing sugar was practically frozen solid. In all three products, however, the effect of freezing was most marked when the point of solidity was approached or attained. When the creams were frozen to apparent solidity, the 40 per cent cream had, on the average, over 80 per cent of the fat thrown out of emulsion, the 25 per cent cream, about 30 per cent, and the 40 per cent cream containing sucrose, about 15 per cent. The figure for 40 per cent cream was somewhat higher than that reported by Webb and

PLATE 1. Cross section of frozen 40 per cent cream.

Hall (5), the difference probably being due to the difference in the method employed for measuring th free fat.

Pressure Developed in Freezing Cream

In the previously reported studies on freezing of skimmilk, whole milk and cream (9), it was noticed that the surface of the samples congealed rather early. As more ice was formed it appeared that the surface layer tended to restrict further expansion causing a pressure which usually bulged the surface in the later stages. Plate 1 shows a photographic view of a cross section of one of the two-quart samples of 40 per cent cream frozen to approximately 90 per cent. It is not difficult to visualize how and why pressure would develop in this freezing mass, when it is considered that the surface freezes over at the very beginning of the freezing process. Using the manometer described, pressure was quite evident and it could be followed during the course of freezing. Average data obtained in six trials with the three types of cream are shown in Figure 2.

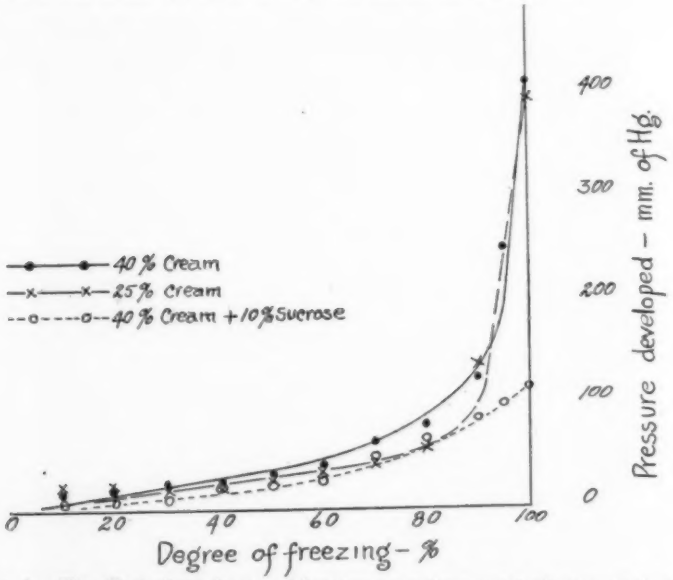

FIG. 2. The effect of the degree of freezing upon the amount of pressure developed in cream.

In the first stages of freezing the pressure increased very slowly. The rate of increase became more rapid, with cream containing no sugar, when freezing had progressed to 60–70 per cent, and increased precipitously between 90 per cent and the apparently solid state. The pressure develop-

ment in 40 per cent cream containing sucrose followed unsweetened cream to the point where the product was about 80 per cent frozen but no great increase in pressure occurred between this point and the state of apparent solidity such as was found in the case of unsweetened cream. The maximum pressure developed in sweetened cream was roughly only one-fourth as great as in unsweetened cream.

Maximum pressure developed in the freezing of all three samples of cream at a point coincident with the point of apparent solidity. Further holding under freezing conditions witnessed a gradual drop in pressure. This is not shown in the figure but is interpreted as indicating a gradual slipping of the congealed surface along the sides of the container and frequently a more pronounced bulging of the surface. Both of these occurrences could be noted by measure but not very accurately.

Further holding under freezing conditions did not materially effect the amount of fat "de-emulsified" in the cream. Because of this fact and the similarity of the curves shown in Figure 1 and Figure 2, it is thought that the pressure developed in cream frozen without agitation is an important

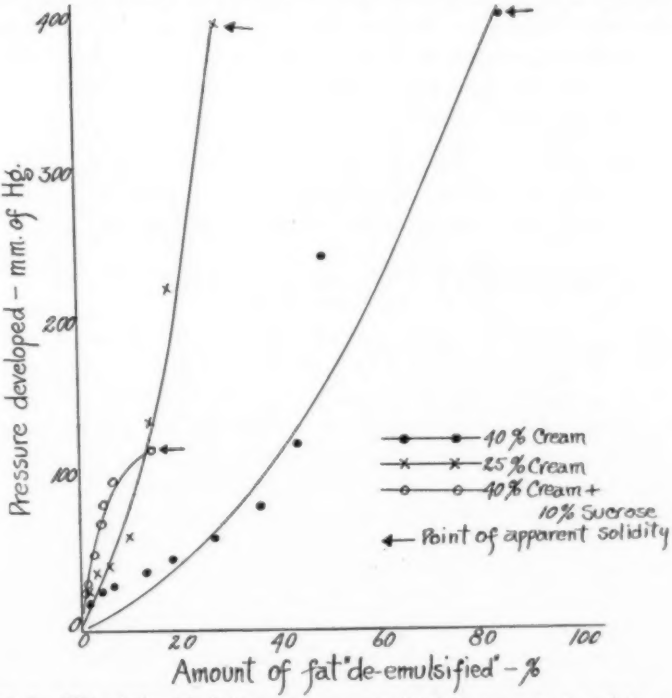

FIG. 3. The relationship between the amount of fat thrown out of emulsion and the pressure developed in freezing cream.

factor (perhaps the most important) in explaining the destruction of the fat emulsion.

Relation Between Pressure and "De-emulsified" Fat

If the data shown in Figures 1 and 2 are plotted to show the relationship between pressure and the per cent of fat "de-emulsified," the curves presented in Figure 3 are obtained. This figure indicates a close relationship between pressure developed during freezing and the amount of fat thrown out of emulsion. The curves are nearly straight lines showing that the per cent of fat "de-emulsified" in the freezing of cream is almost a linear function of the pressure developed. The difference in the amount of fat affected in 25 per cent cream as compared with 40 per cent cream is undoubtedly due to the difference in fat concentration. The difference, in this respect, between unsweetened and sweetened 40 per cent cream is not so easily explained. The low pressure developed in sweetened cream at the point of apparent solidity can be attributed to the smaller ice crystals formed when sugar is present since the small crystals do not build up into a surface structure capable of holding its place against expansion nearly so effectively as does the larger, harder ice structure formed over the surface of unsweetened cream. Furthermore, at a given temperature less water would be frozen in sweetened cream due to the considerably lowered freezing point. This lower maximum pressure is reflected in a much smaller amount of fat thrown out of emulsion. But the amount is still only about one-third as great as occurs in unsweetened 40 per cent cream at a like pressure. The sucrose present must exercise some influence other than that of minimizing the pressure developed, which tends to protect the fat against coalescence.

Similarity Between Freezing and Churning in Destroying the Fat Emulsion of Cream

When frozen and thawed 25 per cent and 40 per cent cream were compared with similar samples churned at 50° F. until approximately the same amount of fat was thrown out of emulsion, it was impossible to distinguish between them in appearance. Under the microscope the fat aggregates were identical, as far as could be judged.

When cream was churned (a small Daisy Churn was used), samples removed periodically during the process showed an increasing pH up to the "breaking point" for the butter followed by a drop to approximately the original value, when the determination was made electrometrically using the quinhydrone electrode. It is believed that this change is more apparent than real, possibly due to an interference with electrical conductivity on the part of the myriads of minute butter particles in the first stages of aggregation. Palmer (10) has shown that electrical conductivity is at a minimum just previous to the "breaking point" of the butter when cream is churned.

This phenomenon of increasing pH as cream is churned probably explains the difficulty encountered by Sharp and McInerney (11) in obtaining the correct values for the pH of cream using the Bailey electrode.

Similar results were obtained when samples of cream were frozen to increasing degrees, thawed and the pH determined. The readings increased with the degree of freezing but since the "breaking-point" for butter was seldom reached (not more than 80–85 per cent of the fat being thrown out of emulsion, even with solid freezing of 40 per cent cream), the increase was not so great and the drop to the original figure did not occur. Comparative data for 40 per cent cream, churned and frozen, are shown in Table 1.

TABLE 1

The pH of 40 per cent cream during churning and during freezing

CHURNING

Description of sample	pH	
	Trial 1	Trial 2
Not churned	6.56	6.60
Viscous stage	6.61	6.66
No sign of butter granules	6.66	6.70
Slightly flaking	6.70	.....
Very small but visible granules	6.81	6.80
Buttermilk	6.54	6.55

FREEZING

Proportion frozen	Proportion fat De-emulsified	Trial 1	Trial 2
%	%		
Not frozen	0	6.53	6.56
20–30	2–5	6.54	6.58
80–90	30–40	6.62	6.63
90–100*	40–60	6.60	6.65
Held solid 4 hrs.	80–85	6.65	6.68

* Apparently solidity.

Whatever is responsible for this effect on the pH values, it is common to cream churning and cream freezing and is interpreted as indicating that the process of fat "de-emulsification" is essentially the same whether the cream emulsion is destroyed by agitation or by the pressure of freezing.

Actually pressure may be an important factor in the destruction of the fat emulsion of milk or cream by whatever means accomplished. In the churning of cream, the tremendous concussion and agitation undoubtedly cause localized, intermittent zones of pressure and the rapidly moving layers of cream, very likely, cause pressure of fat globule on fat globule, gradually wearing away or rupturing the layer of adsorbed protective covering and allowing the free fat to coalesce or adhere to other free fat in such a manner

that butter aggregates are gradually built up in which the individual globules eventually lose their identity.

Pressure and agitation caused by the homogenizer appear to act in similar fashion when cold cream is processed and cold plastic cream containing 70 to 85 per cent of fat, largely in the emulsified state, can be transformed into butter by a suitable application of pressure.

Effect of Freezing on Protein Stability

It seems unnecessary to present further data relative to the effect of freezing on the stability of the protein phase of milk or cream in view of the work already reported, particularly that of Webb and Hall (5). Freezing, *per se,* has no measurable effect on the protein dispersion. Holding in the frozen condition for several weeks or months is required to definitely cause aggregation, denaturization or instability of the proteins.

Inasmuch as it is believed by some that the destruction of the fat emulsion in the freezing of milk and cream is due to the destabilization of the protein agents of emulsion which help to protect the fact, efforts were made to increase the protein stability and lessen or prevent such "de-emulsification." The methods used included the addition of small amounts of sodium citrate and sodium carbonate added to the cream before freezing, and the addition of skimmilk previously heated to 82° C. and cooled. None of these treatments made any noticeable difference in the amount of fat thrown out of emulsion. The conclusion to be drawn, therefore, is that changes in the stability of the protein phase play a very minor rôle in either aiding or preventing "de-emulsification" of the fat when cream is frozen.

CONCLUSIONS

When cream is frozen in containers without agitation, pressure is developed due to the fact that the surface freezes over early and subsequent conversion of water into ice, in the unfrozen center, causes expansion which is partially restricted by the ice structure of the surface.

For cream of uniform fat content, the percentage of fat thrown out of emulsion by freezing is roughly proportional to the pressure developed.

Additions of sugar to cream limit the amount of pressure developed in freezing due to the smaller size of ice crystals which form a less rigid frozen surface and also to the fact that at given temperatures less water freezes. Less fat is "de-emulsified" in sweetened frozen cream than in unsweetened cream and less than in unsweetened cream frozen to the same pressure.

The fat aggregates developed in freezing cream seem to be identical with the fat aggregates caused by agitation such as churning and the mode of formation appears similar.

It is concluded that in the destruction of the fat emulsion brought about by the unagitated freezing of cream, the pressure developed by the con-

gealing water is the causative factor of most importance. The freezing point of the aqueous phase is a factor primarily through its effect on the pressure and the stability of the protein as an emulsifying or protective colloid is not an important factor within the limits of its variability under commercial conditions.

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SOME FACTORS INFLUENCING THE ACIDITY OF FRESHLY DRAWN COWS' MILK[1]

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Kansas Agricultural Experiment Station

INTRODUCTION

In the course of another investigation dealing with normal variations in the curd tension of milk a large number of acidity determinations were made on the fresh milk from individual cows. The results indicated higher average acidity values than have generally been reported in the literature. In several textbooks the acidity of fresh milk has been reported as ranging from 0.10 to 0.14 per cent. Preliminary studies at this station indicated that such low values are not typical of any large number of cows. This observation led to the organization of a project in 1933 for a detailed study of the titratable acidity of fresh milk from individual cows in the Kansas Agricultural Experiment Station dairy herd over an extended period of time.

Factors studied as possibly connected with the acidity of cow's milk were: 1, breed; 2, individuality of the cow; 3, stage of lactation; 4, variations from month to month; 5, variations from day to day, and 6, variations from milking to milking. The acidity of the milk from each cow was determined monthly over a fourteen month period. More frequent determinations were made with selected groups of cows for shorter periods of time in conducting certain phases of the investigation.

PROCEDURE

The technique used by different investigators in determining the titratable acidity of milk has varied widely. This fact undoubtedly is an important factor in the variable results which have appeared in the literature. Sommer and Menos (1) have shown that the addition of an equal volume of water to a sample of milk lowers its titratable acidity approximately 0.02 per cent, and the addition of nine volumes of water lowers it 0.06 per cent. Burgwald and Bachtel (2) found that an increase in the amount or concentration of indicator lowered the results of an acidity determination. This observation has been verified by the authors. When replicate 18-gram samples of whole milk were titrated with varying amounts (3 drops to 2.0 cc.) of a 1 per cent solution of phenolphthalein indicator, the following results were obtained: 3 drops of indicator, 0.172 per cent acid; 0.5 cc.,

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[1] Contribution No. 104, Department of Dairy Husbandry.

0.159 per cent acid; 1.0 cc., 0.154 per cent acid; 1.5 cc., 0.151 per cent acid; and with 2.0 cc. of indicator, 0.149 per cent acid.

These results represent average values obtained by three individuals working independently. In each case eight replicate titrations were made with each quantity of indicator.

The size of milk sample is another variable factor which will affect the results. If a 9 cc. pipette is used, the actual weight of the sample will be approximately 9.27 grams. On the other hand, if a 17.6 cc. pipette is used, the sample will weigh 18 grams. In the calculation of the results the weights of the sample would be considered 9 and 18 grams respectively. Higher results would therefore be expected if a 9 cc. pipette were used as compared to a 17.6 cc. pipette.

It is evident that a carefully standardized procedure for determining the titratable acidity of whole milk must be employed if comparable results are to be obtained. The following procedure was used in the present experiment: A 17.6 cc. (approximately 18 grams) sample of milk was measured into a white cup by means of a whole milk pipette. Four drops of a 1 per cent solution of phenolphthalein indicator were added to the sample. Tenth normal sodium hydroxide was slowly added to the sample from a burette until a faint pink color was observed. The results are expressed as lactic acid in all cases.

In the determination of acidity at monthly intervals a sample of milk from the entire milk of each cow was obtained at the time of the evening milking. The samples were placed immediately in ice water and the acidity determined within 15 minutes.

When it was necessary to obtain samples from both milkings, the same procedure was followed except that the samples collected at the morning milking were held in ice water for a period not to exceed 5 hours before the acidity determination was made.

In studying the influence of lactation on acidity, milk samples were obtained from a group of 10 cows for the first six successive milkings following partuition and at less frequent intervals thereafter over a period of one month. Hydrogen ion determinations were also made by means of the quinhydrone electrode against a saturated calomel electrode at 25° C.

RESULTS

Variations due to breed of cows: The average acidity of the milk for the different breeds varied as follows: Ayrshire, 0.160 per cent; Holstein, 0.161 per cent; Guernsey, 0.172 per cent; and Jersey, 0.179 per cent (Table 1). The acidity of the milk from the Holstein and Ayrshire breeds showed no significant differences. Similarly there was no significant differences in the average acidity of the milk from the Jersey and Guernsey breeds. There is, however, a difference in the acidity of the milk from the higher testing

TABLE 1

Influence of breed on the titratable acidity of fresh milk

BREED	SAMPLES	AVERAGE ACIDITY	COEFFICIENT OF VARIATION
	(No.)	(%)	(%)
Ayrshire	229	0.160 ± .005	4.5
Holstein	297	0.161 ± .004	4.0
Guernsey	153	0.172 ± .005	4.7
Jersey	132	0.179 ± .006	4.3
All breeds	811	0.166 ± .005	4.2

breeds (Jersey and Guernsey) as compared with the Holstein and Ayrshire breeds. The milk from the Channel Island breeds averaged from 0.011 to 0.019 per cent higher than did the milk from the other breeds.

Coefficients of variation ranging from 4.0 per cent for the Holstein breed to 4.7 per cent for the Guernsey breed show that the data were grouped quite closely around the mean values for each of the different breeds.

Variations due to individuality of the cow: While it has been pointed out that the acidity of fresh milk from individual cows varies widely, little data have been presented to indicate the frequency of such variations. The acidity of the milk from individual cows in the present study (exclusive of samples obtained at the very beginning or end of the lactation period) varied from 0.098 to 0.295 per cent. These values are in general agreement with Henkel (4) who examined 10,000 or more samples of individual cow's milk and found them to vary from 0.1237 to 0.2025 per cent. McInerney (5) reported acidity values ranging from 0.10 to 0.22 based upon the ex-

TABLE 2

*Distribution of 811 acidity determinations on freshly drawn milk from individual cows**

INTERVAL PER CENT	PER CENT OF DETERMINATIONS FALLING WITHIN THE INTERVAL INDICATED				
	Ayrshire	Holstein	Guernsey	Jersey	All breeds
0.08–0.0999	0.4	0.0	0.0	0.0	0.1
0.10–0.1199	3.9	1.0	0.0	0.8	1.6
0.12–0.1399	15.7	15.8	9.8	7.6	13.3
0.14–0.1599	25.3	29.3	20.3	7.6	23.0
0.16–0.1799	37.1	35.4	32.0	29.6	34.4
0.18–0.1999	12.6	15.2	28.1	32.6	19.7
0.20–0.2199	4.4	2.0	7.2	19.7	6.5
0.22–0.2399	0.4	0.7	1.3	2.3	1.0
0.24–0.2599	0.0	0.0	0.7	0.0	0.1
0.26–0.2799	0.0	0.7	0.0	0.0	0.1
0.28–0.2999	0.0	0.0	0.7	0.0	0.1
	99.8	100.1	100.1	100.2	99.9

* The samples by breeds were distributed as follows: Ayrshire 229, Holstein 297, Guernsey 153, Jersey 132.

amination of the milk from 42 cows. Somner and Hart (6) found the acidity of 86 tests on individual samples from 31 cows to range from 0.102 to 0.257 per cent.

When the results on 811 milk samples were grouped in a frequency distribution table according to the percentage of acid present it was found that approximately 80 per cent of the samples for the different breeds fell within the following intervals: Holstein and Ayrshire, 0.12 to 0.18 per cent; Guernsey, 0.14 to 0.20 per cent; and Jersey, 0.16 to 0.22 per cent.

For all breeds, 1.7 per cent of the samples analyzed fell below 0.12 per cent acid and only 7.8 per cent of the samples were over 0.20 per cent acid. These data indicate that while the acidity of milk from individual cows varies widely, the percentage of samples falling near either extreme is limited.

Variations due to the lactation period: Colostrum milk from 10 cows was found to be high in acidity (Table 3). Milk samples from this group

TABLE 3

Acidity and pH values of milk samples from ten cows following parturition

	NUMBER OF MILKINGS AFTER PARTURITION					
	1	2	3	4	5	6
Number of cows	10	10	10	10	10	10
Average acidity (%)	0.44	0.34	0.26	0.24	0.24	0.21
Coeff. of variation (%)	16.0	17.0	13.0	19.0	6.0	11.0
Average pH values	6.25	6.33	6.35	6.38	6.36	6.46
Coeff. of variation (%)	5.0	5.0	4.0	5.0	4.0	3.0

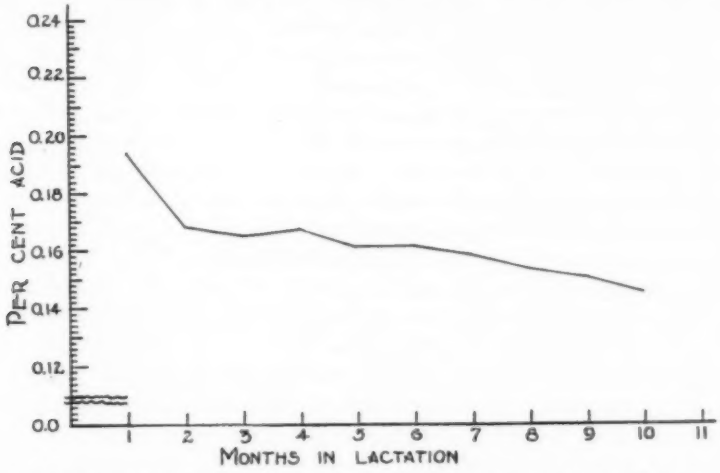
	DAYS AFTER PARTURITION					
	5	10	15	20	25	30
Number of cows	10	10	10	10	10	10
Average acidity (%)	0.20	0.19	0.17	0.16	0.16	0.16
Coeff. of variation (%)	7.0	6.0	5.0	8.0	11.0	12.0
Average pH values	6.47	6.54	6.57	6.58	6.58	6.58
Coeff. of variation (%)	6.0	6.0	3.0	6.0	3.0	2.0

averaged 0.44 per cent acid for the 1st milking, 0.34 per cent for the 2nd milking, 0.26 per cent for the 3rd milking, and at the 6th milking the acidity was 0.21 per cent (Table 3). The pH values were in harmony with the trend in titratable acidity (Table 3).

While the acidity of the milk continued to decline for a period of 15 to 20 days following partuition, the change was most apparent in the first three milkings (Table 3). On the fifth day the average acidity of the milk was 0.20 per cent, on the tenth day 0.16 per cent. No change in either the titratable acidity or pH was observed from the 20th to 30th days respectively.

Coefficients of variation ranging from 6 to 17 per cent for the first six milkings following partuition reflect the variability in acidity for individual cows. All cows within the group, however, showed the same general trend, namely, a high initial acidity followed by a progressive decline during the early part of the lactation period.

Observations made at monthly intervals on a group of 36 cows (12 Ayrshires, 11 Holsteins, 7 Guernseys, and 6 Jerseys) for a complete lactation showed that the acidity of the milk has a tendency to decline throughout the entire lactation (Figure 1). The most significant drop, however, oc-



curred between the first and second months of the lactation. The average acidity of the milk for the first month of the lactation was 0.194 per cent and by the second month it had declined to 0.168 per cent, a difference of 0.026 per cent. From the second through the seventh month of the lactation the average acidity of the milk remained quite constant. Following this a small decline was registered from 0.158 per cent for the seventh month to 0.145 per cent for the tenth month respectively. These data substantiate the findings of Houston (7) who observed a similar trend in the acidity of milk from a group of cross-bred Shorthorn cows.

The stage of lactation has a significant influence on the variability in acidity of milk from an individual cow. It was observed that all cows whose milk showed an acidity of 0.22 per cent or over had been fresh for 15 days or less at the time the determinations were made (Table 2), while extremely low values were usually associated with cows near the end of their lactations.

Although there is a general tendency for the acidity of milk to decline as the lactation advances, individual cows will show considerable variation

in this respect. Data obtained on a group of 8 cows in advanced stages of lactation showed that the average acidity of the milk had declined from 0.14 per cent, approximately one month prior to the end of the lactation, to 0.08 per cent on the last day of the lactation. However, the milk from some of the cows in this group showed very little change, whereas, in other instances a pronounced decline occurred. If a cow is showing good average milk production near the end of a normal lactation period, the decline in acidity does not appear to be so pronounced as when milk production is low. Data taken from two groups of cows during the last month of lactation substantiate this statement. One group of cows with an average daily milk production of 5.8 pounds showed an average acidity of 0.132 per cent, whereas, with a second group of 8 cows producing 15.8 pounds daily, the acidity of the milk averaged 0.169 per cent.

Variations in acidity from month to month: The average acidity of the milk from each of the four breeds showed some variation from one month to the next over a fourteen months' period. The monthly average acidity of the milk from the different breeds varied as follows: Holstein, 0.155 to 0.179 per cent; Ayrshire, 0.148 to 0.166 per cent; Guernsey, 0.172 to 0.189 per cent; and Jersey 0.172 to 0.189 per cent respectively.

Variations in the average monthly acidity for each of the breeds can be attributed primarily to differences in the stage of lactation and to the number and individuality of the cows represented in any one month. Several cows in any one breed freshening in a particular month will result in an increase in the average acidity for that month. Likewise, if several cows in any one breed are in advanced stage of lactation, the average acidity for the month generally will be lower. No seasonal trend was observed in connection with the monthly average acidity of the milk for the different breeds.

Variations from day to day and from milking to milking: Variations in the acidity of the milk for a group of 6 cows were observed over a 10-day period. Acidity determinations were made on samples collected from consecutive milkings for a period of 10 days.

Daily averages for the acidity of the milk from this group of cows did not vary more than 0.012 per cent throughout the 10-day period. It was true also that the differences in the acidity of the morning and evening milk were not significant. On the other hand, the acidity of the milk from individual cows did show some variation. The maximum variation observed between any two consecutive milkings was 0.038 per cent.

SUMMARY AND CONCLUSIONS

The titratable acidity of the freshly drawn milk from all cows in the college dairy herd was determined at monthly intervals over a period of 14

months. More frequent determinations were made with selected groups of cows for shorter periods of time. A total of 811 milk samples were examined (approximately 60 cows) distributed as follows: Holstein, 297; Ayrshire, 229; Guernsey, 153; Jersey, 132. Factors studied were: 1, breed; 2, individuality of the cow; 3, stage of lactation; 4, variations from month to month; 5, variations from day to day; and 6, variations from milking to milking. The following is a summary of the results:

1. The acidity of the milk for the different breeds averaged as follows: Ayrshire, 0.160 per cent; Holstein, 0.161 per cent; Guernsey, 0.172 per cent; and Jersey 0.179 per cent. The milk from all breeds averaged 0.166 per cent acid.

2. The acidity of the milk from individual cows studied varied from 0.098 per cent to 0.295 per cent respectively. Approximately 80 per cent of the samples for any one breed could be grouped within an interval range of 0.06 per cent acid. The limits of the interval, however, must be adjusted for the different breeds.

3. The acidity of colostrum milk was found to be high, averaging 0.44 per cent for the first milking for a group of 10 cows. With each succeeding milking a decrease occurred so that by the third milking the acidity of the milk averaged 0.26 per cent and at the sixth milking the acidity was 0.21 per cent. A gradual decline in acidity occurred during the first 15 to 20 days of the lactation.

4. The acidity of the milk from a group of 36 cows showed a gradual decline throughout the lactation. The most pronounced changes occurred near the beginning and end of the lactation period. From the second through the seventh month of the lactation the acidity remained fairly constant.

5. A marked decline in the average acidity of milk was observed during the last month of the lactation period. The extent of the change, however, varied widely between individual cows.

6. Variations from month to month in the acidity of milk for the different breeds were not large. Differences in the stage of lactation and in the number and individuality of the cows represented in any one month appear to be responsible for the variations in the monthly breed averages for acidity which were found to occur.

7. Average variation in the acidity of milk from day to day and from milking to milking for a group of 6 cows over a 10-day period were not significant. The milk from individual cows within the group did show some variation from one milking to the next. The maximum variation between any two consecutive milkings was 0.038 per cent.

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INTRA-MAMMARY DUCT INJECTIONS IN THE STUDY OF LACTOSE FORMATION*

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As intravenous injections of sugars did not prove satisfactory in the production of a hyperglucemic condition, it was decided to study the effect of introducing sugars into the mammary gland upon the blood sugar level. Several literature references supported probable success of the idea. Jackson and Rothera (5) were the first to report a decrease in lactose content of milk if the removal milk was reintroduced into the udder. Davidson (2), studying the effect of incomplete removal of milk, found a subsequent lowering of the lactose content. Petersen and Rigor (6) injected lactose solutions into the udder and found tremendous reductions in lactose when removed twelve hours later.

THE PROBLEM

The disappearance of lactose observed by Petersen and Rigor indicated that absorption had occurred, so it was decided to perform similar injections and watch the milk, blood, and urine for changes in sugar content. As the right and left halves of the udder are completely separated, one gland can be used for injection and serve as a constantly draining reservoir. The other gland can be used for a study of the effect upon the milk. As no name has been given to this type of injection, it was decided to use the term "intra-mammary duct injection" throughout this paper.

METHODS

Injections. The intra-mammary duct injections were made through an ordinary teat canula and by means of gravity. The solutions were sterilized and buffered with sodium bicarbonate.

Sampling. Blood, milk and urine samples were collected regularly. Micturition was artificially stimulated whenever samples were to be collected.

Analysis. Milk sugar was determined by the picric acid method according to Bierman and Doan (1), blood sugar and urine sugar according to Shaffer-Hartman (7) on the filtrates prepared according to Folin-Wu (4).

The unfermentable sugars were determined by the same technique after chloroform and yeast treated urine had stood at room temperature for about

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thirty hours. The values obtained from blank determinations of normal urine of similar specific gravity were deducted from the results as a means of correction for the naturally occurring copper reducing substances normally present in cow's urine.

EXPERIMENTAL

The first study consisted of a group of five experiments, the object of which was to determine whether or not it was possible to raise the blood sugar level by the intra-mammary duct injections of sugar solutions of varying strengths and to determine whether hypotonic, isotonic and hypertonic solutions had similar physiological effects. Guernsey cow 538 and Jersey cow 153 were used for this purpose. In Experiment 1, cow 538 was given an intra-mammary duct injection of isotonic glucose, in Experiment 2 an hypertonic glucose injection, and in Experiment 3 a hypotonic glucose solution. In Experiment 4, cow 153 was given an intra-mammary duct injection of isotonic glucose, and in Experiment 5 the same cow was injected with isotonic lactose. The varying details of all these experiments are given in the protocols which accompany the graphically illustrated results of each. The technique was the same in all five experiments and consisted of stripping the gland at the regular morning milking period and then injecting into the right half of the gland a volume of sugar solution equal to that of the milk obtained from it. Blood and urine samples were collected at intervals of about one hour, and the temperature changes of the animal were recorded. No milk was removed from the gland until the regular evening milking period. The results obtained are illustrated in Figures I, II, III, IV, and V. The five preliminary experiments showed clearly that it was quite possible to cause hyperglucemia by the intra-mammary duct injection of sugar solutions, so, further experiments were carried out to determine the practical value of this method in our studies.

In Experiment 6, a solution of hydrolyzed lactose was injected into cow 153, and hourly samples of milk were collected for lactose analysis besides the usual hourly blood and urine samples. In Experiment 7, the same cow was injected with a fructose solution and milk, blood and urine samples collected. The results of these two experiments are graphically illustrated in Figures VI and VII, which are also accompanied by the protocols of the two experiments.

In the experiments already mentioned at was noted that the blood sugar was increased during only a portion of the time. It was, therefore, thought desirable to attempt to produce a hyperglucemic condition for a longer period of time. With this object in mind, three experiments were conducted in which the technique was varied to include a milking out of a certain quantity of the injected solution at about the middle of the experiment and its replacement by the same volume of freshly prepared sugar solution.

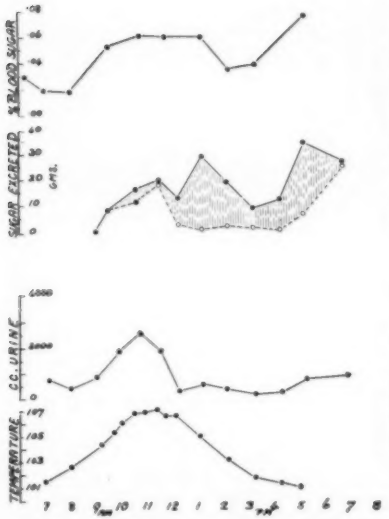


FIG. I. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF ISOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. Shaded portion—Unfermentable sugar. o—o—o—o—o—Fermentable sugar.

April 19, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 1.
Protocol.

Intra-mammary duct injections of 3700 cc. 5.4% glucose into right half gland.

6: 10	A.M.	Commenced injection, finished at 6: 20 A.M.
8: 00	"	Tremors started.
8: 30	"	Tremors ceased.
10: 00	"	Slight twitching over body, hiccough action.
3: 45	"	Commenced rumination, apparently normal during remainder of experiment.

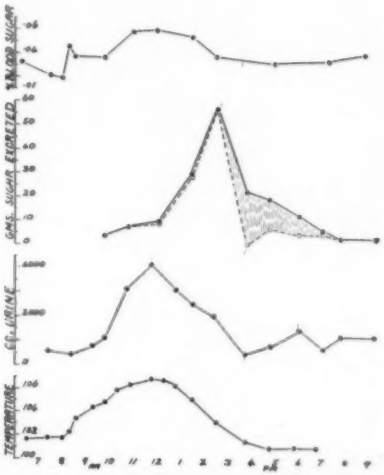


FIG. II. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF HYPERTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. Shaded portion—Unfermentable sugar. o—o—o—o—o—Fermentable sugar.

April 23, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 2.

Intra-mammary duct injections of 3625 cc. 8% glucose, right half gland.

6: 45	A.M.	Commenced injection, finished at 6: 55 A.M.
8: 15	"	Commenced to quiver in neck.
8: 17	"	Quivering in flanks.
8: 22	"	General tremors.
8: 23	"	Violent tremors.
8: 37	"	Extremely violent tremors.
8: 45	"	Tremors spasmodic.
9: 15	"	Ruminating, animal apparently normal during the remainder of experiment.

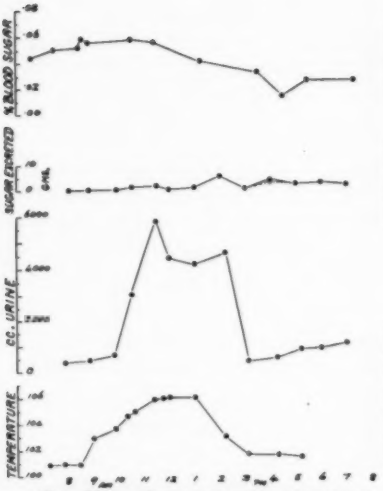


FIG. III. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF HYPOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL.

Shaded portion—Unfermentable sugar.

o—o—o—o—o—o—Fermentable sugar.

April 29, 1930. Guernsey Cow 538.

Intra-mammary Duct Experiment 3.

Protocol.

Intra-mammary duct injection of 4000 cc. 2.7% glucose, left half gland.

6: 35 A.M. Commenced injection, finished at 6: 45 A.M.
8: 10 " Animal apparently normal.
8: 12 " Tremors commenced.
8: 22 " Tremors violent.
8: 26 " 30 cc. 20% $CaCl_2$ solution injected.
8: 34 " Tremors extremely violent and continuous.
8: 43 " Tremors intermittent.
8: 47 " Hiccough action.
8: 50 " Feeding normally.
10: 10 " Hiccough action every five minutes.
10: 40 " Slight twitching flanks and thighs.
10: 50 " Animal apparently normal during remainder of experiment.

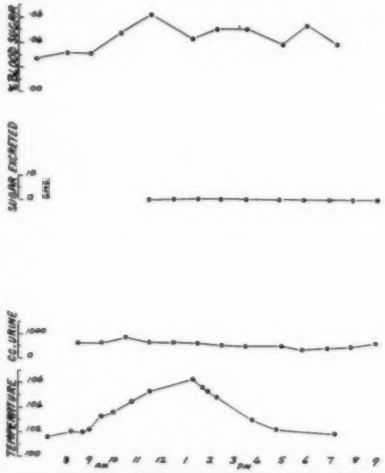


FIG. IV. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF ISOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL.

May 1, 1930. Jersey Cow 153.

Intra-mammary Duct Experiment 4.

Protocol.

Intra-mammary duct injection of 3900 cc. 5.4% glucose, left half gland.

6:52 A.M. Commenced injection, finished at 7: 10 A.M.
8: 25 " Feeding normally.
8: 40 " Apparently quite normal.
1: 30 P.M. Slight panting.
2: 30 " Animal apparently normal during remainder of experiment.

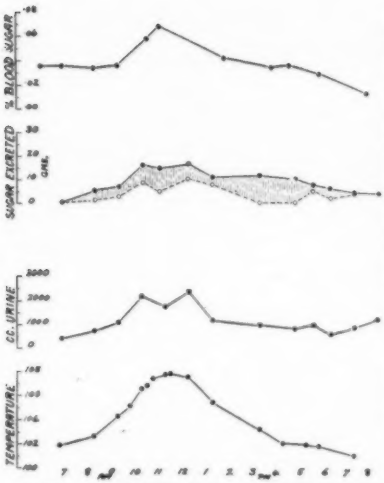


FIG. V. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF ISOTONIC LACTOSE SOLUTION UPON BLOOD SUGAR LEVEL.

Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

May 6, 1930. Jersey Cow 153.

Intra-mammary Duct Experiment 5.

Protocol.

Intra-mammary duct injection of 4000 cc. 8.8% lactose, right half gland.

6: 45	A.M.	Commenced injection, finished at 7: 05 A.M.
10: 25	"	Vigorous tremors hind quarters.
10: 33	"	Very vigorous tremors.
10: 55	"	Tremors practically over, intermittent, most of tremors in rear quarters.
10: 57	"	Marked twitching between hook and pin bones.
11: 00	"	Increased tremors.
11: 05	"	Tremors intermittent.
11: 10	"	Tremors more marked.
11: 20	"	Hiccough symptoms.
11: 22	"	Vigorous tremors, easing of hind feet common symptom over whole of above period.

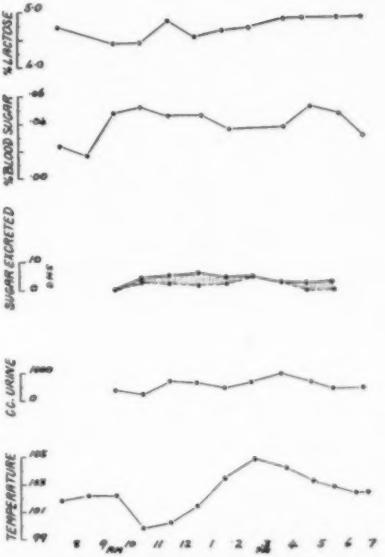


FIG. VI. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF HYDROLYZED LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

November 30, 1930. Jersey Cow 153.

Intra-mammary Duct Experiment 6.

Intra-mammary duct injection of 2500 cc. 6.2% hydrolysed lactose, right half gland.

7: 30	A.M.	Commenced injection, finished at 7: 40 A.M.
11: 45	"	Momentary twitching of flanks following the taking of blood sample.
11: 47	"	Ruminating, apparently normal.
12: 30	"	Animal started to ease weight alternately from right to left hind legs, giving a swaying motion to its rear end. Swaying intermittent and of about 30 seconds' duration.

11:25 " Intermittent tremors, five second intervals.
11:30 " Tremors ceased.
11:40 " Humped back, very very restless.
11:45 " Decided tremors throughout, restless.
11:50 " Apparently normal during remainder of experiment.
2:00 " Animal apparently normal during remainder of experiment.

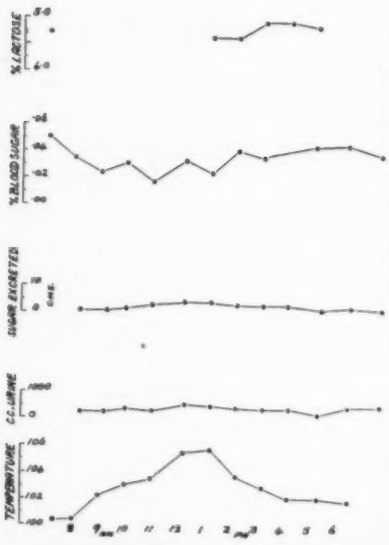


FIG. VII. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF FRUCTOSE UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

December 6, 1930. Jersey Cow 153.
Intra-mammary Duct Experiment 7.

Intra-mammary duct injection of 2500 cc. of 5.4% fructose, right half gland.

7:00 A.M. Commenced injection, finished at 7:10 A.M.
Animal apparently normal during whole of experiment.

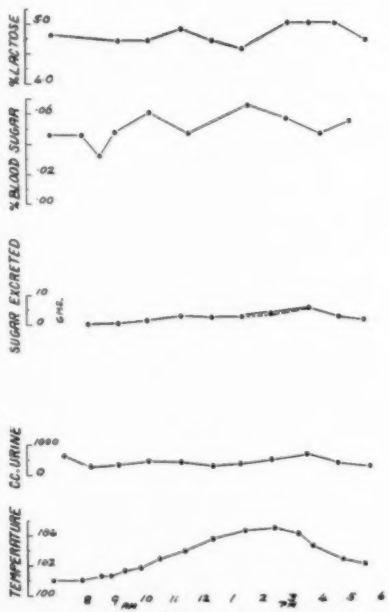


FIG. VIII. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF GLUCOSE SOLUTION UPON THE LACTOSE CONTENT OF MILK.
Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

May 13, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 8.
Protocol.

Intra-mammary duct injection of 4000 cc. of 5.4% glucose, right half gland.

6:50 A.M. Commenced injection, finished at 7:00 A.M.

7: 50 " Animal lying down, champing jaws.

9: 00 " Apparently quite normal, ruminating.

11: 25 " Milked out 2000 cc. from right half gland and replaced it by same quantity of 10.8% glucose solution.

Animal apparently normal during remainder of experiment.

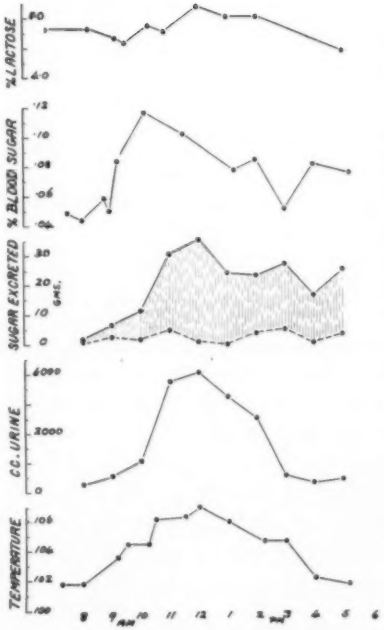


FIG. IX. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

Shaded portion—Unfermentable sugar.

o—o—o—o—o—Fermentable sugar.

May 19, 1930. Guernsey Cow 538.

Intra-mammary Duct Experiment 9.

Protocol.

Intra-mammary duct injection of

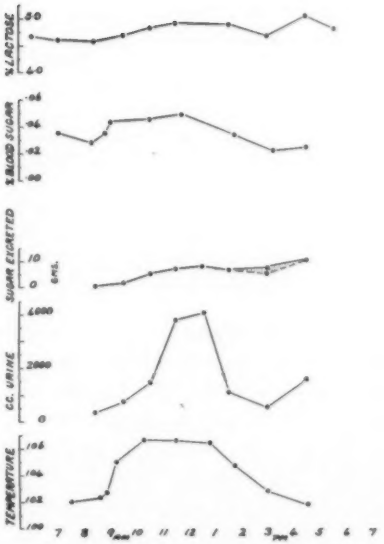


FIG. X. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF HYDROLYSED LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

Shaded portion—Unfermentable sugar.

o—o—o—o—o—Fermentable sugar.

June 10, 1930. Guernsey Cow 538.

Intra-mammary Duct Experiment 10.

Protocol.

Intra-mammary duct injection of 4000 cc. of 6.2% hydrolyzed lactose, right half gland.

7: 00 A.M. Commenced injection, finished at 7: 14 A.M.

4000 cc. of 8.8% lactose, right half gland.

6:53	A.M.	Commenced injection, finished at 7: 08 A.M.
8: 00	"	Animal apparently normal.
8: 40	"	Tremors commenced .
9: 10	"	Tremors ceased.
10: 30	"	Slight tremors, blood clots easily.
10: 35	"	Tremors throughout, marked shivering, hiccough motion, very marked quivering of neck.
10: 42	"	General tremors.
10: 43	"	Tremors spasmodic.
1: 10	P.M.	Milked out 2000 cc. from right half gland and replaced it by same quantity of 10.5% lactose solution. Animal apparently normal during remainder of experiment.
7: 40	"	Animal apparently normal.
8: 44	"	Commenced to tremble, shivering quite general and very constant, less spasmodic than usual.
9: 08	"	Tremors spasmodic, very strong.
9: 12	"	Tremors spasmodic, back arched.
9: 13	"	Tremors subsiding.
9: 15	"	Tremors stopped.
10: 55	"	Animal arched back every few seconds.
11: 35	"	Milked out 1000 cc. from right half gland and then replaced it by same quantity of 12.6% hydrolyzed lactose solution.
11: 40	"	Slight tremors, arched back.
11: 45	"	Animal apparently normal during remainder of experiment.

In Experiments 8, 9 and 10, cow 538 was thus injected twice with glucose, lactose and hydrolyzed lactose solutions respectively. Blood, urine, and milk samples were collected, and the results obtained are illustrated in Figures VIII, IX and X, along with their accompanying protocals.

As a matter of interest in Experiment 11, 800 units of insulin were injected four hours after the intra-mammary duct injection in order to determine the effect of insulin upon an animal in an hyperglucemic condition form this cause. Figure XI indicates the results obtained.

DISCUSSION OF RESULTS

The considerable variation noted between the blood sugar curves, the urine output, the amount of sugar excreted and the absence or occurrence of tremors, following the intra-mammary duct injections, may be due to differences in the rate of the passage of sugar into the blood stream, individual differences in the manner of disposal of the sugars or to an unrecognizable condition of the animal prior to the commencement of the experiments.

However, in a general way, the blood sugar curves show certain resemblances which, along with the fact that the intra-mammary duct injections have resulted in a pronounced hyperglucemic condition, indicates that the method offers some promise in this and similar problems.

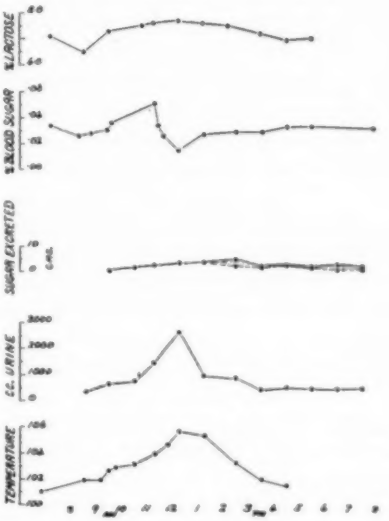
FIG. XI. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF ISOTONIC GLUCOSE SOLUTION UPON BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK, WHEN FOLLOWED BY THE INTRAVENOUS INJECTION OF 800 UNITS OF INSULIN.

Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

May 27, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 11.
Protocol.

Intra-mammary duct injection of 4000 cc. of 5.4% glucose solution, right half gland.

7: 19	A.M.	Commenced injection, finished at 7: 30 A.M.
9: 25	"	Slight tremors.
9: 30	"	Tremors ceased.
11: 18	"	800 units insulin injected into jugular vein.
11: 18	"	Tremors commenced.
11: 23	"	General tremors, not vigorous, back arched, legs under.
11: 38	"	Tremors intermittent, hiccough motion.
12: 04	P.M.	Tremors ceased.
12: 04	"	Feeding normally, apparently normal during remainder of experiment.



The commonest experience was to find that, after an intra-mammary duct injection, the animal remained apparently normal for about ninety minutes but then suddenly became quite restless and immediately passed into a condition of tremors, lasting for approximately one-half hour. The tremors subsided as quickly as they had commenced, leaving the animal apparently normal. The tremors occurred only in seven of the eleven experiments.

The onset of tremors was always (with the exception of those occurring following an insulin injection) closely followed by a marked blood sugar rise, and accompanied by a temperature rise which reached its peak in about four hours. The temperature subsidence to normality was at about the same rate. The temperature rise was always perfectly reflected by the diuresis which accompanied it. While much water was excreted by the animals during the diuresis, no abnormal thirst was noticed.

When no tremors were produced the temperature rise was slower, and the peak of the temperature curve was reached from one to two hours later. In

these experiments no diuresis occurred, although appreciable quantities of sugar were excreted.

The cause for this difference in experimental effect produced in the same animals at different times, because of the appearance or non-appearance of diuresis, appears to lie in a difference in the state of hydration of the animal at the commencement of the experiment.

The tremors are not identical with those of insulin shock, but, as they were produced three times while the blood sugar was either normal or in a slightly hyperglucemic condition and four times during hypoglucemia, the cause is obscure. In spite of this, it nevertheless appears that the blood sugar is somewhere connected with this syndrome because the commencement of the tremors was usually coincident with a marked blood sugar rise.

That the diuresis is not directly caused by the sugar appears probable, because, while this condition was most pronounced in Experiment 3, only traces of sugar were excreted, and again because in those experiments where no diuresis occurred considerable amounts of sugar were nevertheless excreted.

The origin of the tremors as due to a calcium upset is not indicated because in Experiment 3 30 cc. of $CaCl_2$ were injected into the jugular vein during the tremors, without noticeable effect; and again because in Experiments 8 and 9, hourly blood calcium determinations failed to show any abnormal changes.

While no general abnormality was apparent in the animals following the experiments, the amount of milk secretion was subnormal for four or five days, but after this time the normal amount of secretion returned.

The evidence of Experiments 5 and 9, where the injected sugar, lactose, appeared in the urine within one hour, indicates that the sugar commences to pass into the blood stream very soon after the injection. In spite of this evidence, no marked hyperglucemia occurred in any of the experiments until a much longer period. In seven of the eleven experiments a hypoglucemic condition actually occurred before the hyperglucemia.

A possible explanation of this lag may be that the first appearance of sugar entering the blood initiated an increased insulin activity (or increased glycogen formation), and that a hyperglucemia was not possible until the excess sugar had finally temporarily exhausted the sugar removal mechanism. Contrary to this, as in Experiment 3, when the hypotonic glucose solution was injected, probably so little sugar at first passed into the blood that no increased activity immediately occurred; but when the sugar inflow became greater, the stimulus supplied was more than adequate to take care of the injected sugar so that some of the naturally occurring blood sugar was also removed, and hypoglucemia resulted.

It, therefore, appears as though it is essential to inject more than enough sugar to exhaust the insulin (or retard the glycogen formation) in order to

produce hyperglucemia, or hypoglucemia will occur. In the light of this explanation, the cause of the failure of the intravenous sugar injections becomes apparent.

While an explanation of the general common trend of the blood sugar curves has been attempted, it appears at present advisable to disregard the minor fluctuations occurring in the individual curves and to consider them only with reference to their major points.

As no milk was removed from the gland in the first five experiments, the results of these must be considered separately. In the first four experiments glucose was injected, but in the fifth lactose was used. In Experiment 1, cow 538 was injected with isotonic glucose; in Experiment 2, with hypertonic glucose; and in Experiment 3, with hypotonic glucose.

The first two injections produced quite similar results which included marked tremors, a temperature rise, diuresis, a hypoglucemia followed by hyperglucemia, and an excretion of considerable amounts of an unfermentable sugar which was identified as lactose. In Experiment 3, the results produced were tremors, a temperature rise, a slight hyperglucemia, followed by a pronounced hypoglucemia, and considerable diuresis. No unfermentable sugar was found in the urine. In Experiments 1 and 2 the amount of unfermentable sugar in the urine was greatest after the peak of the hyperglucemia had been reached. While some of the unfermentable sugar may have had its origin in the injected half of the gland, the bulk of it appears to have come from the uninjected portion from which it poured into the blood stream to compensate for the disturbance of equilibrium brought about by the blood sugar drop. While the first two experiments showed this condition most plainly, the same type of excretion was also observed in Experiments 8 and 11. In the two latter cases, the lactosuria is on a much smaller scale because the uninjected half of the gland had been milked out at frequent intervals. That no lactosuria occurred in Experiment 3 is possibly due to the fact that the resulting hypoglucemia had reduced the lactose secretion below the point where it could take active part in an equilibrium interchange.

A second cow, 153, was used in the two remaining experiments of this series. In Experiment 4, isotonic glucose was injected, and in Experiment 5 isotonic lactose. Unfortunately in Experiment 4, while a marked hyperglucemia and temperature rise occurred, the non-appearance of the tremors and diuresis changed the picture so that a comparison with Experiment 1 was difficult.

That the tremors were not an idiosyncrasy of cow 538 was evidenced in Experiment 5 when 153 exhibited an abnormally long period of tremors after a lactose injection. The lactose excreted commenced one hour after the injection, but reached its maximum after the blood sugar peak had been reached.

In Experiment 6, hydrolyzed lactose was injected into cow 153. In this experiment no tremors occurred, but the hyperglucemia was marked and the hourly lactose determinations showed an apparent increased lactose secretion towards the end of the experiment.

The same animal was injected with fructose in Experiment 7, but again no tremors occurred and unfortunately several of the milk samples were accidentally discarded. A qualitative test for fructose failed to show its presence either in the milk or the urine.

Following these experiments, it was thought that the extent and duration of hyperglucemia might be increased by a second sugar injection. With this in view in the next three experiments, part of the contents of the injected half of the gland were milked out at a time estimated to coincide with the maximum hyperglucemia, and replaced by a double strength sugar solution. In Experiment 8, where cow 538 received two injections of glucose, the second injection appeared to increase the hyperglucemia; but in Experiments 9, when lactose was injected, and 10, when hydrolyzed lactose was used, the second injection appeared to reduce the blood sugar. From this experience, it is considered that a second injection is of doubtful value.

In Experiment 11, cow 538 was given a glucose injection and then, when the hyperglucemia was thought to be near its peak, 800 units of insulin were administered intravenously. The insulin injection, which resulted in a pronounced hypoglucemia, was immediately followed by vigorous tremors which commenced and stopped long before the point of maximum hypoglucemia. The hypoglucemia following the insulin injection was reflected in the trend of the lactose secretion during the remainder of the experiment.

After the intra-mammary duct injections, the blood sugar curves are reflected in the lactose curves. These latter curves appear more regular than those usually obtained with normal animals. The most irregular curve of the group is that following the lactose injection, which itself resulted in such marked blood sugar fluctuations.

One noticeable feature of the injections has been that while it is apparently easy to produce hyperglucemia, no matter how large the amount of sugar injected, the blood sugar was only raised appreciably above .060 per cent in one instance when lactose was used. From this it appears as though .060 per cent must be about the renal threshold for the animals used, and that the reason the lactose injection caused such a marked hyperglucemia was because the body could not readily utilize this sugar but instead had to depend entirely upon the kidneys for its removal.

The high, level portions of the lactose curves appear to be the effect of the sugar injections, but the magnitude of the increases was much smaller than was anticipated. From these experiments it is now realized that the demonstration of an increase in lactose is a much more difficult undertaking than that of a decrease. It appears that lactose synthesis has been nicely

adjusted to the average blood sugar level which maintains optimum synthesis. That the optimum synthesis is very close to maximum synthesis appears probable, because while even a slight hypoglucemia tends to depress the lactose secretion, a marked hyperglucemia does not have as great an opposite effect.

The disappearance of the sugar from the blood soon after its passage from the gland indicates a ready utilization in the animal body. Of the sugars injected, glucose, fructose, and galactose are apparently quite easily disposed of without excretion; but the appearance of lactose in large quantities in the urine seems to show that this sugar is not as readily utilized as the more simple ones.

In regard to the question of sugar excretion, it appears as though the efficiency of the various sugar removal mechanisms is affected by very slight changes in the animal's condition, and that the amounts of sugar disposed of by excretion are subject to such wide fluctuations that a quantitative determination is not of much importance.

Incidental to these studies, some additional light seems to have been thrown on the mechanism of the formation of colostrum.

In this connection several former discoveries have been considered along with this work. In the first place, that lactosuria is commonly found just before and immediately following parturition in many species of mammals has long been known. Then Eckles and Palmer (3) discovered that if cows are milked regularly up to the time of parturition the secretion obtained after parturition more nearly resembles normal milk than it does colostrum. Further Jackson and Rothera found that if a portion of milk were returned to the udder after stripping, the next milking produced a secretion very low in lactose but high in ash. Davidson then reported that an incomplete milking tends to decrease the lactose secretion for the two following days, and finally Petersen and Rigor discovered that if a lactose solution were injected into the gland, this lactose had been largely removed from the secretion which was milked out twelve hours later and that its place had been taken by ash. Furthermore, the secretion obtained from the gland for the first two or three days after such an injection more nearly resembled colostrum than it did normal milk.

In these experiments it is indicated that lactose can readily pass from the mammary gland ducts into the blood, and that it does so if the concentration within the gland is above the level of the amount of blood sugar secreting it.

All of the abve mentioned observations point to the conclusion that the reason for the lactosuria before and immediately after parturition is that the mammary gland has been secreting normal milk, but that because the elaborated milk has not been removed from the gland, soon after it was formed, a pressure has been built up causing some of the milk constituents

to be broken down, others partially reabsorbed, and in the case of the lactose its resorption and replacement by salts.

Viewed in this light colostrum, therefore, would not be a distinct secretion of the mammary gland, but rather an equilibrium product formed from true milk after the external pressure in the mammary gland ducts has stopped normal milk synthesis.

SUMMARY

1. Intra-mammary duct injections were found to be a practical way of producing hyperglucemia in the bovine.

2. Because the inflow of sugar from the mammary gland apparently stimulates increased insulin activity, sufficient sugar must be injected to exhaust the insulin supply, or hypoglucemia will result.

3. In some cases a marked condition of tremors was produced.

4. Failure to produce tremors in some of the experiments is thought to be due to a partial dehydration of the animals.

5. The onset of a pronounced diuresis accompanied the tremors.

6. The diuresis is thought to be more nearly related to the tremors than to the injected sugar.

7. It appears that a hyperglucemic condition results in a slight increased lactose secretion.

8. The evidence available indicates that colostrum may be an equilibrium product of normally secreted milk rather than a special secretion of the mammary gland.

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INFLUENCE OF PRECEDING DRY PERIOD AND OF MINERAL SUPPLEMENT ON LACTATION

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INTRODUCTION

A number of independent factors affect milk and butterfat production by dairy cows. Previous papers have dealt with the effects of season, advancing lactation and environmental temperatures upon butterfat percentages (4), and of season and advancing lactation upon milk production (3) by Jersey cows. This study deals with length of the dry period and use of bonemeal with low-calcium rations, as factors affecting milk production.

Optimum length of the dry period as it influences subsequent lactation has been determined only under limited conditions. Dairy text-books give recommendations on desirable lengths of dry period, based on general practice and observations rather than on detailed studies of milk records. The latitude and environment of Florida, where the present study was made, differ widely from conditions prevailing in other regions where observations have been recorded.

The common forage crops grown on acid sandy soils in the Coastal Plains have a low content of calcium; consequently it is desirable to use a mineral supplement with them when such roughages are fed to dairy cows. Calcium is one of the elements involved in storage in the skeleton during the dry period.

The two conditions mentioned above made it advisable to analyze local records of milk production to obtain more definite information applicable to this region.

REVIEW OF LITERATURE

Management practices

Ten widely used text-books in dairy husbandry, published between 1911 and 1930, recommend that cows have a dry or rest period ranging from 4 to 10 weeks in length. The majority of texts favored 6 to 8 weeks, depending on the physical condition of the cow. The practice of drying off cows as they approach parturition has been developed from the experience of practical farmers and dairymen over a period of more than a century, rather than based on the results of planned experiments. Culley (9) in 1786 mentioned that cows fattened quickly when they were turned dry. Dickson (10) in 1805 stated that there was a difference of opinion among English farmers of that period—some favoring a two-months' dry period, while others believed periods as short as ten days sufficient.

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Other early writers who favored dry periods of 6 weeks to 2 months include "a Lincolnshire grazier" (1), Flint (12), Le Cornu (15), Le Conteur (16), Linsley (17), Skinner (20) and Youatt and Martin (22).

Alvord (2) stated that six weeks should be the longest time allowed for a cow to be dry before calving. Woodward and Dawson (21) held that the length of dry period should depend on quantity of milk a cow produced and upon her condition as regards fatness. Copeland (8) summarized the Jersey Herd Test records and showed that on the average of all herds, the cows were dry 15.39 per cent of the time, or that the average dry period was of eight weeks' duration.

Gavin (13) analyzed 347 records of dairy cows in an English herd, and found a reduced maximum daily yield for those cows dry less than 35 days. No advantage was gained by cows dry longer than this period. Carroll (6) studied two years' records of a Utah cow testing association, and observed that a long dry period reduced annual yields of butterfat; that for the highest production, a cow needed a longer rest than one month, and that a dry period of more than two months added nothing to the yield of milk and butterfat. The highest average butterfat yield per year and the highest average first-month butterfat yield followed dry periods two months in length.

Hammond and Sanders (14) studied records of 408 cows and noted that cows dry 80 to 119 days gave 14.2 per cent more milk, and cows dry 40 to 79 days gave 10.9 per cent more than did cows dry 39 days or less. They concluded that, "It would appear that a cow's yield is considerably lowered by a very short dry period, but not greatly increased by a very long one."

Mineral supplement

Meigs and Woodward (19) supplied di-sodium phosphate to seven cows during dry periods about two months in length. During the 30 days beginning ten days after calving, 37.9 per cent more milk was produced than in a similar period in the previous lactations. Meigs (18) reported that cows receiving alfalfa hay high in calcium decreased in milk yield less rapidly than did other cows on a low calcium ration containing timothy hay.

Twelve Jersey cows at the Florida station received low-calcium rations over a period of years. The rations of these 12 cows subsequently were supplemented with bonemeal. Milk yields were tabulated for these two periods, and it was observed (5) that there was an increase of 50.16 per cent in total milk production while the cows were receiving the rations adequate in calcium.

STATEMENT OF PROBLEM

Acid sandy soils low in available lime make up a large part of the Gulf Coast and Coastal Plains regions. The lands on which pasture and silage crops were grown for the Jersey cows at the Florida station fall in this class. Roughages grown on these soils supplied an insufficient amount of calcium

to the station cows (5). Prior to 1929, the cows in this herd received mainly home-grown roughages and purchased concentrates. The concentrates consisted principally of wheat bran, cornmeal, cottonseed meal and linseed oilmeal, all low in available calcium. Two per cent of finely ground feeding bonemeal has been added to the mixed concentrates since January, 1929. At the same time a limited amount of alfalfa hay was made available to some of the higher producing cows. Under the earlier feeding practices an unusual proportion of the Jersey cows suffered broken hips and ribs, yet remained fat, and did not yield milk in proportion to the offering of concentrates. Under these conditions, what influence does length of dry period and use of bonemeal exert upon the subsequent milk production of dairy cows?

PLAN OF INVESTIGATION

The complete normal lactation records of all Jersey cows in the station herd were assembled. Lactation curves were tabulated by 10-day periods, including the date of calving as the first day. Milk yields were computed to a uniform age basis, using the factors obtained by Clark (7) on Jersey cows milked twice daily in experiment station herds under other than official testing conditions. These records were divided into five classes according to the length of preceding dry periods. One class comprised initial lactations of heifers. The remaining classes were those of cows dry 30 days or less, 31 to 60 days, 61 to 90 days, and 91 days or more preceding the lactations. Since the rations were changed as regards mineral supplement in January, 1929, and substantial increases in milk yields resulted, the lactations previous and subsequent to the inclusion of bonemeal in the concentrates, are grouped separately. Weighted averages were calculated, combining the same classes in both groups.

PRESENTATION AND DISCUSSION OF RESULTS

A total of 291 complete lactations following normal calving of registered and a few high grade Jersey cows were assembled for study under the plan outlined above. These records were of cows milked twice daily. In a few instances some of the cows failed to conceive and were milked longer than 400 days. Any record after the 400th day was excluded from this study.

The 218 records of milk production on the low calcium rations were divided as follows: 53 initial lactations; 10 of cows dry 30 days or less prior to the lactation; 54 dry 31 to 60 days; 45 dry 61 to 90 days, and 56 dry longer than 90 days. The records obtained while cows received rations adequate in calcium totalled 73, divided into corresponding classes which contained 15, 9, 22, 14 and 13 records, respectively.

The maximum milk yield followed dry periods 31 to 60 days in length, as shown from the weighted averages of each class of records given in Table 1. With adequate calcium, milk production in the class dry 61 to 90 days

was slightly greater than in the 31 to 60 day class. However, too few records are included in the 61 to 90 day class, and the difference of only 188 pounds of milk between these two classes is too small to be significant.

TABLE 1

Influence of length of dry period in relation to milk yields of Jersey cows on low-calcium rations, and on rations adequate in calcium contents

DRY PERIOD	NUMBER OF LACTATIONS	AVERAGE YIELDS PER LACTATION			PERCENTAGE OF BASE YIELD*
		On low-calcium rations	On adequate rations	Average	
		pounds	*pounds*	*pounds*	*per cent*
Initial	53	4,632.0	.....	.....	.....
lactation	15	.....	7,581.6	.....	.....
	68	.....	.....	5,306.0	91.87
30 days	10	4,806.2	.....	.....	.....
or less	9	.....	5,926.5	.....	.....
	19	.....	.....	5,335.6	92.38
31–60 days	54	5,188.1	.....	.....	.....
	22	.....	7,185.1	.....	.....
	76	.....	.....	5,775.5*	100.00
61–90 days	45	4,937.7	.....	.....	.....
	14	.....	7,373.0	.....	.....
	59	.....	.....	5,468.0	94.68
91 days	56	4,690.9	.....	.....	.....
or more	13	.....	6,878.0	.....	.....
	69	.....	.....	5,126.9	88.77
Weighted	218	4,856.0	.....	.....	.....
average	73	.....	7,092.7	.....	.....
	291	.....	.....	5,420.9	.....

* Since a dry period of 1 to 2 months has been recommended popularly, the milk yields for this group were used as a base with which to compare those of other groups.

Requirements for growth, storage, reproduction and maintenance are involved with heifers. They have no depletion of calcium and phosphorus to replace, whereas mature cows have to restore their depleted reserves during the dry period, maintain their bodies, and provide for a foetus. The initial lactations of heifers on rations adequate in calcium were significantly greater than from those on low-calcium rations.

The lactation curves

The combined average lactation curves which show influence of the preceding dry period, weighted by numbers of records, are presented in Figure 1. The initial lactations tended to be more persistent than did the

others. The maximum daily yield of the heifers was lower and the rate of decline more gradual, so that their average daily production after the 265th day was the highest of all classes. The maximum daily milk yield was highest for the class dry 31 to 60 days.

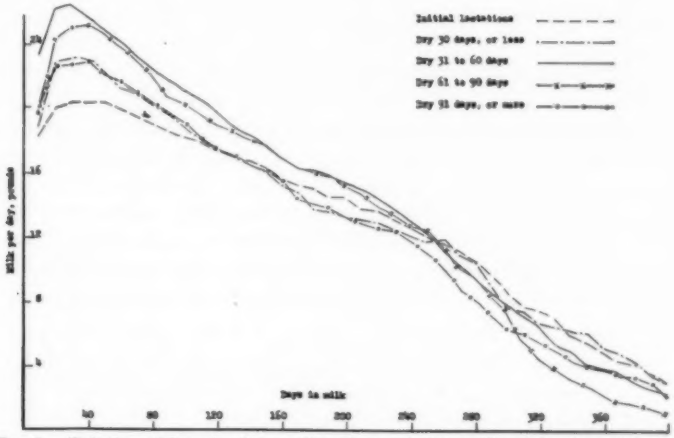

FIG. 1. Relation of length of preceding dry period to milk production of Jersey cows in the Florida station herd.

Cows dry 30 days or less declined more rapidly in daily milk yield up to the 180th day than thereafter. This class, in both the low-calcium and adequate calcium groups, tended to decrease in milk yield less rapidly after the 180th day, up until the expected normal decline due to advancing stage of gestation. It may be interpreted that this more rapid early decline coincides with the period of heaviest withdrawal of stored nutrients (fat and mineral matter) and the flattening of the rate of decline accompanies this time when the daily feed is sufficient to provide all the nutrients for daily milk production. The difference in mineral intake accounts for the difference in level of daily production. The less depleted storage and higher daily intakes of calcium account for the more persistent production toward the close of lactation in the adequate-calcium group. We are unable to state whether or not the exhaustion of internal stimulus (hormones) for milk production occurs at the end of this 180-day period.

The class dry 31 to 60 days had the highest maximum daily production (26.4 pounds), followed by a reasonably uniform rate of decline to the close of the eighth month of lactation, when it dropped off gradually. The classes dry 61 to 90 days, and 91 days or more, parallel each other closely throughout the entire lactations, and were intermediate between initial lactations and those of cows dry 31 to 60 days.

The greatest influence upon the lactation rate resulting from length of dry period appears to be exhibited in the first four months after parturition.

Influence of bonemeal supplement

The relation of the amount of calcium provided by typical rations during these years and the calcium requirements of the cows was discussed in a previous paper (5).

Milk production of 12 Jersey cows studied earlier (5) increased 50.16 per cent in amount as the result of supplementing low-calcium rations with bonemeal. Individuality was not a factor since the milk yields were by identical cows before, and while, using the rations supplemented with bonemeal.

The present study covers all available normal lactations in the station Jersey herd, including the 12 cows mentioned above. Between 1917 and 1928, when the cows were on low-calcium rations, the average production for 218 lactations was 4,856 pounds of milk. Between 1929 and 1932, when the concentrates fed to the cows were supplemented with two per cent of bonemeal, 73 lactations averaged 7,084.5 pounds of milk. These average lactation curves are shown in Figure 2.

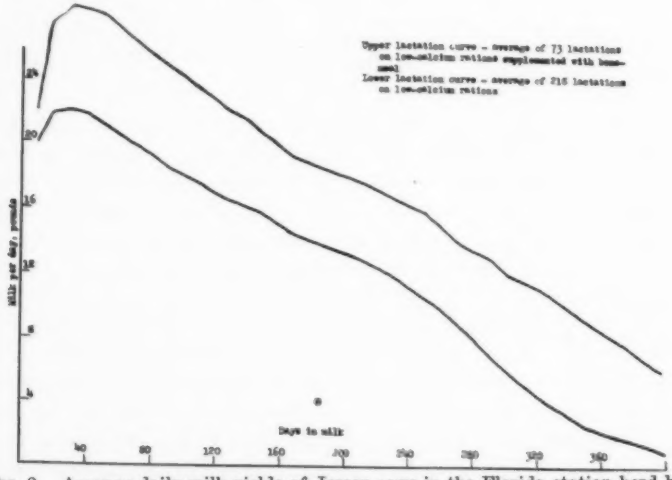

FIG. 2. Average daily milk yields of Jersey cows in the Florida station herd before, and during, the use of bonemeal as a supplement to low-calcium rations. All lactations were computed to a uniform age basis.

Thus it is seen that the increase in milk yield in this case amounted to 45.88 per cent. This compares with an increase of 50.16 per cent in the previous study with identical cows. General feeding conditions other than as regards calcium supply were quite similar in both studies. Increased production for these larger groups is additional evidence that deficiency of

calcium was a limiting factor in milk production, and that bonemeal was a satisfactory supplement to correct the deficiency. It is noted in Figure 2 that the milk yield of Jersey cows was higher at the peak of production, and remained higher throughout the entire lactation, while the cows were receiving rations adequate in calcium. Milk yields of cows on the low-calcium rations decreased more rapidly after the middle of the lactation period than did the yield of cows on the adequate rations.

STATISTICAL ANALYSES

Analyses were made of the differences in the rate of decline in milk production of Jersey cows while on the low-calcium rations, and the adequate-calcium rations, as shown in Table 2. When the χ^2 test of homogeneity and the standard error of difference were calculated,* it was found that the low-calcium lactations had a different rate of decline than did those on the rations adequate in supply of calcium. The chances were less than 1 in 100 that these two rates of decline were identical.

TABLE 2

Average milk production calculated from 218 lactations of Jersey cows on low-calcium rations, and 73 lactations on rations adequate in calcium, at the Florida station between 1917 and 1932

MONTH	PRODUCTION ON LOW-CALCIUM RATIONS			PRODUCTION ON ADEQUATE-CALCIUM RATIONS		
	Average milk yield	Monthly decrease	Rate of production	Average milk yield	Monthly decrease	Rate of production
	pounds	*pounds*	*per cent*	*pounds*	*pounds*	*per cent*
1	639.0	.....	13.16	782.5	.....	16.11
2	637.5	.....	13.13	835.1	.....	17.20
3	580.6	56.89	11.96	769.3	65.86	15.84
4	528.1	52.51	10.88	705.8	63.50	14.53
5	485.6	42.42	10.00	642.4	63.41	13.23
6	436.6	49.02	8.99	578.0	64.35	11.90
7	401.2	35.44	8.26	542.5	35.49	11.17
8	357.6	78.98	7.36	502.6	39.96	10.35
9	294.0	63.64	6.05	448.4	54.13	9.23
10	211.4	82.57	4.35	388.1	60.31	7.99
11	135.6	75.85	2.79	333.8	54.28	6.87
12	82.4	53.14	1.70	274.7	59.16	5.66
13	54.3	28.14	1.12	218.9	55.74	4.51
(10 days)	12.2	.....	0.25	62.4	.....	1.29
Total	4,856.0	.....	100.00	7,084.5	.....	145.88

Differences in average daily milk production on the low-calcium and adequate calcium rations were calculated for both this study and the previous one (5). When these *differences* were graphed in Figure 3 for visual

* These calculations were carried out according to the methods outlined in Chapters 4 and 5 of Fisher (11).

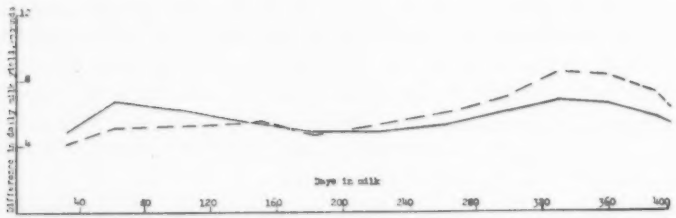

FIG. 3. The broken line represents the average differences in daily milk production between 44 lactations of twelve Jersey cows on low-calcium rations, and 22 lactations on rations adequate in calcium. The solid line represents differences between 218 lactations of Jersey cows on similar low-calcium rations, and 73 lactations on those adequate in calcium, between the years 1917 and 1932. These average daily differences throughout the lactation periods followed a similar trend, and were in excess of four pounds of milk per day.

comparison, again a close similarity was noted in results obtained in the two studies. These differences in milk yield varied slightly in the early months of lactation. They were lower about the sixth and seventh months, and increased after the middle of the lactation. The increasing differences after the seventh month of lactation are believed to be related directly to the stage of depletion of calcium storage and to the intake on the low-calcium rations. Cows on the inadequate rations decreased in milk production more rapidly.

SUMMARY

A dry period of 31 to 60 days has been found in this study to allow maximum milk yields by Jersey cows. A dry period of longer than 91 days appeared to result in lower milk production than did shorter dry periods. Dry periods of less than 30 days appeared to cause an early decline in milk yield, corresponding perhaps to the stage of withdrawal of stored nutrients in the body.

The use of bonemeal as two per cent of the concentrates in supplementing rations that contained roughages grown on acid sandy soils resulted in a 45 per cent increase in milk production with 73 records, over that of 218 lactations on the low-calcium rations.

A statistically significant difference was found in rates of decline in milk production between the groups on low-calcium and on adequate-calcium rations.

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THE EFFECT OF CERTAIN FACTORS UPON THE KEEPING QUALITY OF BUTTER

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The factors which have been considered in a study of the causes for the spoilage of butter held at temperatures which might permit the growth of microorganisms were: the presence of the natural enzymes of milk; the increase in numbers of certain types of bacteria; the ripening of the cream; and the addition of salt. Quality was determined by scoring the butter on the basis of flavor and odor.

All butters in any series were made from the same cream, the bacteriological content of which was determined. The composition of the butters was controlled by careful chemical analyses. The bacterial content of the fresh, unsalted butter made from raw, sweet cream indicates the quality of the cream used and the precautions taken in making the butter. The numbers and types of bacteria present at the various stages of the holding period were determined on milkfat agar (1, 2), tributyrin agar (3), and skimmilk agar (4), as described in a previous report (5). The importance of these types of microorganisms in the deterioration of milk and dairy products has been observed by previous workers (2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16).

The hydrolysis of fat by the natural lipase in milk has been shown by Schmidt (17), Rogers and his associates (18, 19), Rice and Markley (20), Nair (21), deTomasi and Sharp (22), Krukovsky (23), and others. Nair mentioned the importance of lipase in the spoilage of milk products. It is agreed by workers in this field that milk lipase is destroyed by heating at 140° F. (62.8° C.) for 10 minutes. Krukovsky has recently shown that a pH of 4.7 or less irreversibly inactivates milk lipase. The effect of salt upon lipase activity is not definitely known. The oxidizing enzymes sometimes present in milk, cream, and butter are known to be inactivated by high acidity and to be destroyed by 170° F. (76.5° C.) for 10 minutes (19, 24, 25, 26).

In the presence of certain microorganisms and at a temperature at which they can grow, the preserving action of acid and salt is well known. In the absence of excessive numbers of microorganisms or at temperatures too low to permit their growth, either acid, or acid and salt, has been shown to hasten the chemical deterioration of butter (27, 28, 29, 30, 31, 32, 33, 34).

During the past two years five different series of butter have been studied. Holding temperatures of 41° F. (5° C.), 50° F. (10° C.), and 75.2° F. (24° C.) have been employed. When all conditions were similar, except the temperature of holding, the quality of all the butters tended to approach the

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TABLE 1

The effect of pasteurization, milk enzymes, acid, and salt upon the keeping quality of butter—series E

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in			
							water	butter		
Butter Made from Cream Pasteurized at 165° F. (73.9° C.) for 30 Minutes										
Unsalted butter made from sweet cream										
0	100	<10	<10	<10	6.60	13.08	.....	.....	40	
9	120,000	900	40,000	7,000	.....	.....	.....	.....	38	
21	440,000	3,800	39,000	<10	.....	.....	.....	.....	38	
36	100,000	<10	50,000	<10	.....	12.24	.....	.....	37	sl. old
Salted butter made from sweet cream										
0	100	0*	0	0	6.60	12.95	13.91	2.09	40	
9	400	0	0	0	.....	.....	.....	.....	37	oily
21	300	0	0	0	.....	.....	.....	.....	37	oily
36	1,700	0	0	0	.....	11.43	15.21	2.05	36	oily
Unsalted butter made from sour cream										
0	6,900,000	0	0	0	4.61	13.90	.....	.....	40	
9	1,800,000	0	0	0	.....	.....	.....	.....	38	
21	378,000	0	0	0	.....	.....	.....	.....	38	
36	140,000	0	0	0	.....	12.88	.....	.....	36	stale
Salted butter made from sour cream										
0	950,000	<10	<10	<10	4.61	13.06	14.46	2.21	40	
9	6,900	<10	<10	<10	.....	.....	.....	.....	37	oily
21	500	400	200	500	.....	.....	.....	.....	35	oily
36	1,000	100	100	500	.....	12.33	16.07	2.36	30	oily

TABLE 1—(*Continued*)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in			
							water	butter		
				Butter Made from Raw Cream						
				Unsalted butter made from sweet cream						
0	13,000	<10	600	<10	6.35	13.09	.....	.....	37	
9	480,000	8,000	160,000	<10	.....	.....	.....	.....	28	bitter
21	960,000	11,000	160,000	2,600	.....	.....	.....	.....	30	old
36	430,000	1,900	80,000	1,000	.....	12.65	.....	.....	28	strong
				Salted butter made from sweet cream						
0	12,000	0	500	0	6.35	13.16	14.14	2.17	37	
9	9,600	0	5,000	0	.....	.....	.....	.....	31	rancid
21	40,000	0	18,000	0	.....	.....	.....	.....	31	old
36	54,000	0	20.000	0	.....	11.14	16.93	2.27	29	stale
				Unsalted butter made from sour cream						
0	7,700,000	0	0	0	4.40	13.63	.....	.....	37	
9	330,000	0	0	0	.....	.....	.....	.....	37	old
21	185,000	0	0	0	.....	.....	.....	.....	36	old
36	130,000	0	0	0	.....	13.03	.....	.....	35	old
				Salted butter made from sour cream						
0	980,000	0	0	0	4.40	13.14	14.49	2.27	37	
9	1,000	0	0	0	.....	.....	.....	.....	32	strong
21	600	0	0	0	.....	.....	.....	.....	30	fishy
36	100	0	0	0	.....	11.41	17.14	2.36	29	fishy

TABLE 1—(*Continued*)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in water	Salt in butter		
					Butter Made from Cream Pasteurized at 145° F. (62.8° C.) for 30 Minutes					
					Unsalted butter made from sweet cream					
0	100	0	0	<10	6.59	12.63	.....	.....	40	
9	13,000	0	0	6,000	.....	.....	.....	.....	38	old
21	304,000	0	0	0	.....	.....	.....	.....	37	old
36	13,000	0	0	0	.....	11.49	.....	.....	30	stale
					Salted butter made from sweet cream					
0	100	0	0	0	6.59	11.91	14.78	2.06	40	
9	100	0	0	0	.....	.....	.....	.....	37	oily
21	100	0	0	0	.....	.....	.....	.....	37	oily
36	100	0	0	0	.....	11.19	15.86	2.11	33	old
					Unsalted butter made from sour cream					
0	3,400,000	0	0	0	4.64	13.13	.....	.....	40	
9	1,000,000	0	0	0	.....	.....	.....	.....	38	
21	508,000	0	0	0	.....	.....	.....	.....	38	
36	131,000	0	0	0	.....	11.83	.....	.....	36	oily
					Salted butter made from sour cream					
0	2,100,000	0	0	0	4.64	14.08	13.20	2.14	40	
9	7,800	0	0	0	.....	.....	.....	.....	38	
21	300	0	0	0	.....	.....	.....	.....	37	
36	100	0	0	0	.....	12.52	15.23	2.25	35	oily

* 0 Actually means less than 10 bacteria per gram of butter.

same level; the rate of spoilage was faster at the higher temperature and slower at the lower temperature. Since the data obtained on two lots of butter, Series D and E, held at 50° F. (10° C.) illustrate the principles involved in all of the series held at the various temperatures, only these results are presented. These data have more practical value because of the proximity of 50° F. (10° C.) to the temperature found in ice-boxes and refrigerators in grocery stores and homes.

The results obtained from a study of butter, Series E (Table 1), indicate that practically all of the natural milk enzymes are destroyed by 165° F. (73.9° C.) for 30 minutes. Inasmuch as this unsalted butter made from sweet cream was not at any time found to contain large enough numbers of bacteria to be of practical significance, this butter illustrates keeping quality in the absence of all spoilage factors considered in this study. The score at the end of 36 days was 37, the judge considering the butter to be only slightly old. When salt was added to some of this fresh butter, the final score was 36 with a criticism of oily, showing the slightly harmful effect of salt. Butter made from the same cream soured was found to have approximately the same keeping qualities as the salted sweet cream butter. The combined and increased deteriorating effect of salt and acid is easily observed by the low score, 30.

The quality of butter made from the same cream unpasteurized shows very clearly the rôle played by natural milk enzymes in the spoilage of butter; it is believed that the numbers of bacteria in the raw, sweet cream, unsalted butter are too small to be of any great significance, and that the difference between the scores 37 and 28 is due to the action of natural milk enzymes in the butter made from unpasteurized cream. When salt was added to some of this fresh butter made from raw, sweet cream, the final score indicated that salt did not prevent the action of milk enzymes. The difference in score between 36 and 29 is believed to be due to milk enzyme activity in the salted butter made from raw, sweet cream. The score given to the sour cream butter, 35 at the end of 36 days holding, shows that acid inhibits the action of milk enzymes. As would be expected, the salted, sour cream butter deteriorated more rapidly and more completely.

It is known that pasteurization at 145° F. (62.8° C.) destroys lipase and removes certain more volatile substances, but that it does not destroy certain other milk enzymes. These facts explain the final flavor scores: 28 for raw, sweet cream, unsalted butter; 30 for 145? F. (62.8° C.) sweet cream, unsalted butter; and 37 for 165° F. (73.9° C.) sweet cream, unsalted butter.

The effect of salt upon the action of milk enzymes is not well understood. The data here presented lead one to believe that salt does not inhibit (stop) lipase action, but that it does retard (slow down) the action of enzymes which resist the 145° F. (62.8° C.) pasteurization. These statements are substantiated by a comparison of these scores: 36 for 165° F. (73.9° C.)

TABLE 2

The effect of pasteurization, milk enzymes, acid, and salt upon the keeping quality of butter—series D

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in water	Salt in butter		
					Butter Made from Cream Pasteurized at 165° F. (73.9° C.) for 30 Minutes					
					Unsalted butter made from sweet cream					
0	500	<10	100	100	6.59	19.45	.....	.....	40	
9	58,000,000	18,000,000	14,000,000	18,000,000	.....	.....	.....	.....	38	
21	138,000,000	41,000,000	3,600,000	138,000,000	.....	.....	.....	.....	34	stale
36	29,800,000	28,400,000	900,000	29,800,000	.....	.....	.....	.....	28	stale
					Salted butter made from sweet cream					
0	50	0*	0	0	6.59	13.20	13.50	2.06	40	
9	56	0	0	0	.....	.....	.....	.....	38.5	
21	14,200	0	0	0	.....	.....	.....	.....	36.5	old
36	1,800,000	0	0	0	.....	.....	.....	.....	36	old
					Unsalted butter made from sour cream					
0	6,700,000	0	0	0	4.72	14.93	.....	.....	40	
9	3,200,000	0	0	0	.....	.....	.....	.....	38	
21	920,000	0	0	0	.....	.....	.....	.....	37	old
36	350,000	0	0	0	.....	.....	.....	.....	36	old
					Salted butter made from sour cream					
0	60,000	0	0	0	4.72	13.85	14.40	2.33	40	
9	34,000	0	0	0	.....	.....	.....	.....	37.5	metallic
21	15,000	0	0	0	.....	.....	.....	.....	36	oily
36	5,000	0	0	0	.....	.....	.....	.....	33	fishy

TABLE 2—(*Continued*)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in water	Salt in butter		
					Butter Made from Raw Cream					
					Unsalted butter made from sweet cream					
0	1,850,000	170,000	340,000	179,000	6.55	14.78	.....	.....	40	
9	8,000,000	1,760,000	1,760,000	3,000,000	.....	.....	.....	.....	33	rancid
21	7,000,000	800,000	800,000	600,000	.....	.....	.....	.....	28	stale
36	9,900,000	6,500,000	1,400,000	2,400,000	.....	.....	.....	.....	28	stale
					Salted butter made from sweet cream					
0	490,000	0	20,000	400,000	6.55	15.13	15.19	2.71	40	
9	250,000	0	3,000	160,000	.....	.....	.....	.....	36	old
21	394,000	0	10,000	34,000	.....	.....	.....	.....	30	old
36	586,000	0	17,000	31,000	.....	.....	.....	.....	30	rancid
					Unsalted butter made from sour cream					
0	3,030,000	0	4,500	0	4.70	15.37	.....	.....	40	
9	6,200,000	0	0	0	.....	.....	.....	.....	36.5	old
21	2,610,000	0	0	0	.....	.....	.....	.....	35	old
36	1,980,000	0	0	0	.....	.....	.....	.....	35	old
					Salted butter made from sour cream					
0	35,000	0	8,300	0	4.70	13.96	13.45	2.17	40	
9	1,980	20	0	0	.....	.....	.....	.....	37	old
21	1,500	0	0	0	.....	.....	.....	.....	34	oily, old
36	1,200	0	0	0	.....	.....	.....	.....	31	oily

TABLE 2—(*Continued*)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in			
							water	butter		
Butter Made from Cream Pasteurized at 145° F. (62.8° C.) for 30 Minutes										
Unsalted butter made from sweet cream										
0	60	0	0	0	6.66	15.54	.....	.....	40	
9	4,800,000	0	0	0	.....	.....	.....	.....	37	old
21	19,200,000	10,300,000	0	10,300,000	.....	.....	.....	.....	28	stale
36	560,000	0	0	0	.....	.....	.....	.....	28	stale
Salted butter made from sweet cream										
0	100	0	0	0	6.66	13.48	13.32	2.07	40	
9	120	0	0	0	.....	.....	.....	.....	37	old
21	100	0	0	0	.....	.....	.....	.....	33	old
36	1,600	0	0	0	.....	.....	.....	.....	32	old
Unsalted butter made from sour cream										
0	5,900,000	0	0	0	4.74	13.86	.....	.....	40	
9	3,700,000	0	0	0	.....	.....	.....	.....	37	sl. metallic
21	840,000	0	0	0	.....	.....	.....	.....	35	sl. metallic
36	360,000	0	0	0	.....	.....	.....	.....	34	stale
Salted butter made from sour cream										
0	13,000	0	0	0	4.74	14.16	13.26	2.16	40	
9	2,400	0	0	0	.....	.....	.....	.....	37.5	oily
21	100	0	0	0	.....	.....	.....	.....	34	oily
36	300	0	0	0	.....	.....	.....	.....	33	fishy

* 0 Actually means less than 10 bacteria per gram of butter.

(lipase and oxidase were destroyed by heat) sweet cream, salted butter; 33 for 145° F. (62.8° C.) (lipase destroyed by heat, oxidase present) sweet cream, salted butter; and 29 for raw, sweet cream, salted butter (lipase and oxidase present).

The data presented in this study and results obtained by other workers indicate that high acidity definitely inhibits the action of milk enzymes. A comparison of the scores obtained on sour cream unsalted butters, 36 for 165° F. (73.9° C.) (no lipase or oxidase present), 36 for 145° F. (62.8° C.) (lipase absent, oxidase present) and 35 for raw (both lipase and oxidase present) (Table 1), confirm these observations.

The data obtained from a study of Series D butter are shown in Table 2. These results are presented to confirm the observations and interpretations reported on Series E butter, and to show the effect of bacterial action on butter in the absence of natural milk enzymes. The difference between the final scores of 37 on 165° F. (73.9° C.), sweet cream, unsalted butter (Table 1), and 28 on 165° F. (73.9° C.), sweet cream, unsalted butter (Table 2), is believed to be due to the action of the bacteria upon the constituents of the butter. Heat resistance tests made on these bacteria showed that they were destroyed by 145° F. (62.8° C.) for 30 minutes, which indicates recontamination after pasteurization. The increase in their numbers during the holding period proved their ability to grow in butter. The deteriorating effect of casein digesting bacteria is also indicated on one sample (after 21 days holding) of unsalted butter made from sweet cream pasteurized at 145° F. (62.8° C.) for 30 minutes. In the absence of other spoilage factors, a direct correlation seems to exist between the numbers of fat splitting and casein digesting bacteria present and the spoilage of the butter held at temperatures which will permit the growth of bacteria.

DISCUSSION

Attention might be called again to the fact that only a small percentage of the data accumulated have been presented in this report, but that all the available data confirm the findings presented. It should also be mentioned that bacterial spoilage of butter while stored under commercial conditions is recognized to be of only minor importance; but that the importance of spoilage due to the growth of certain types of bacteria in butter previous to and after removal from commercial storage should not be minimized. Since the keeping quality of butter is affected by so many factors, no direct comparison between the score of the butter and the holding temperatures was possible. In general terms, however, the higher the holding temperature the more rapid was the spoilage of the butter.

These data show that butter having the best keeping quality was unsalted and made from sweet cream pasteurized at 165° F. for 30 minutes. Probably 200° F. by the flash process would be required to accomplish results

equal to 165° F. for 30 minutes. Since the numbers of bacteria were so small, it is not possible to make a definite statement as to whether recontamination occurred in the pasteurized cream previous to or during the butter-making process, or while the butter was being printed. It is also not known whether recontamination of butter by bacteria capable of causing spoilage would occur more frequently in butter made under experimental or commercial conditions. But it is believed that the importance of butter spoilage due to recontamination, after pasteurization, by bacteria which can cause spoilage should not be overlooked.

SUMMARY

The effect of natural milk enzymes, bacteria, acid, and salt upon the keeping quality of butter held at temperatures which might permit the growth of bacteria, has been studied.

Five series of butter consisting of five hundred seventy-six samples, made and held under known and carefully controlled conditions, have been examined.

The results obtained and the data presented seem to justify the following conclusions:

1. Pasteurization of cream at 165° F. (73.9° C.) for 30 minutes destroys most, if not all, of the harmful natural milk enzymes.
2. All milk enzymes harmful to the keeping quality of the butter were not destroyed by pasteurization of the cream at 145° F. (62.8° C.) for 30 minutes.
3. The action of milk enzymes in butter was retarded little, or none, by salt.
4. The action of milk enzymes in butter was definitely inhibited by pH 4.7, or less.
5. None of the non-spore-producing bacteria, found to be of importance in the spoilage of butter, were able to survive 165° F. (73.9° C.) for 30 minutes.
6. In the absence of other spoilage factors, a direct correlation seems to exist between the number of fat splitting and casein digesting bacteria and the keeping quality of the butter.
7. The well known inhibiting action of acid and salt upon the growth of bacteria in butter was confirmed.
8. The presence of either acid or salt in butter, not containing other spoilage factors considered in this study, resulted, after storage, in a poorer quality butter.
9. The combined deteriorating effect of both acid and salt was shown.
10. As would be expected, all butters examined spoiled more rapidly at the higher holding temperatures.

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EFFECT OF LIPOLYSIS ON THE CHURNABILITY OF CREAM OBTAINED FROM THE MILK OF COWS IN ADVANCED LACTATION

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The long churning time which is often encountered in cream separated from the milk of cows in advanced lactation is usually attributed to the small size of the fat globules. This explanation was indicated by Van Slyke (6), and since then has been generally accepted. Hunziker, Mills and Spitzer (3) performed direct experiments from which they concluded that small fat globules require a longer churning time than large ones.

Palmer (4), on the other hand, as a comment to his studies of the lipolytic activity of the milk of cows in advanced lactation, said that the lengthening of the churning time of such cream might be explained as due to the formation of soaps from fatty acids liberated by lipolysis. This explanation has been accepted by Eckles, Combs and Macy (2). If lipase activity is of importance, this type of churning difficulty should be influenced greatly by the temperature of separation of the milk and by immediate pasteurization. (See Sharp and de Tomasi (5) for a discussion of the effect of these factors on lipase activity.)

EXPERIMENTAL

Milk from cows in advanced lactation was held below 5° C. for 24 hours in order to solidify the fat in the fat globules. Then the milk was divided into two parts. One part was separated at 10–15° C. with the fat globules in the solid state, and the other at 45–50° C. with the fat globules in the liquid state. The milk was separated by centrifuging in glass tubes. The cream was standardized with its own skim milk. After being held at 5° C. for 24 hours, each lot of cream was subdivided. One part was churned at once, one part was held for an additional 24 hours before churning, and one part was heated to 70° C. and held cold for an additional 24 hours before churning.

The churning was accomplished by placing 25 ml. of cream in 75 ml. test tubes and shaking the test tubes in a machine. The shaking machine was placed in a room with a temperature between 14 and 17° C. The percentage increase in volume of cream during churning was recorded. In most instances the titratable acidity at the time of churning was determined. Sanitary precautions were observed so that at the end of the experiments the bacterial counts were under 10,000 per ml.

The data which are presented in Table I show quite clearly that the cream

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TABLE I

Effect of temperature of separation on the foaming and churning time of cream from the milk of cows in advanced lactation

Temperature of churning 14°–17° C.

COW	SEPARATION TEMPERATURE	HEAT TREATMENT CREAM	CREAM HELD BEFORE CHURNING	ACIDITY AS LACTIC ACID	TIME OF CHURNING—MINUTES												
					10	15	20	25	30	35	40	45	50	55	60	65	70
					Per cent increase in volume over that at-start												
No.	*° C.*		*hrs.*	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Cream: 34.00% fat																
	10°–15°	Raw	24	.23	70	70	70	70	70	50	50	40	20	Butter			
	10°–15°	Raw	48	.325	85	85	85	85	85	85	85	70	70	70	70	70	70**
	10°–15°	Heated*	48	.20	70	70	50	40	20	20	20	Butter					
	45°–50°	Raw	24	.15	20	20	20	20	Butter								
	45°–50°	Raw	48	.16	20	20	20	20	Butter								
	45°–50°	Heated*	48	.....	7	7	7	7	Butter								
2	Cream: 31.00% fat																
	10°–15°	Raw	24	.32	85	85	85	85	85	85	85	70	70	70	70	70	70**
	10°–15°	Heated*	48	.....	55	55	55	55	55	55	55	55	55	55	55	55	55**
	45°–50°	Raw	24	.15	40	40	40	20	20	Butter							
	45°–50°	Heated*	48	.....	40	40	20	20	20	Butter							
3	Cream: 30.00% fat																
	10°–15°	Raw	24	.19	40	40	40	40	40	20	Butter						
	10°–15°	Raw	48	.23	40	40	40	40	40	40	40	40	40	40	Butter		
	10°–15°	Heated*	48	.18	20	20	20	20	20	20	Butter						
	45°–50°	Raw	24	.14	40	40	40	20	Butter								
	45°–50°	Heated*	48	.....	7	7	7	7	Butter								

* Heated 24 hours after separation.

** Not churned at the end of 2 hours.

from milk separated at 45–50° C. churned in a much shorter time and foamed less than the cream separated at 10–15° C. A difference in titratable acidity and a marked difference in butyric acid odor were observed. It should be remembered that the milk had stood for 24 hours before it was separated, during which time considerable lipolysis had occurred. Pasteurization had a beneficial effect, particularly in the case of the cream separated at 10–15° C., which was held for an additional 24 hours before churning.

A second series of experiments was performed in which the milk immediately after milking was divided into two parts. One part was pasteurized; the other was not. Both parts were held below 5° C. for 24 hours and were then separated by centrifuging in glass cups at 10–15° C. The cream thus obtained was divided into parts which were heated, churned at once, or held an additional 24 hours before churning, as indicated in Table II. Table II shows that if the milk is pasteurized immediately after milking, the cream obtained by separation at a low temperature churns readily, with no abnormal foaming, and shows no increase in acidity on holding, neither does it develop the odor of butyric acid.

These experiments indicate that no particular difficulty should be encountered in churning cream from the milk of cows in advanced lactation, if the milk is pasteurized or heated soon after it is drawn, or the milk is separated at once, with the fat in the liquid state, and the cream immediately pasteurized.

The application of this principle is not confined to the difficulty, often encountered on the farm, in churning the cream from one or two cows but is the basis for the practice adopted by some milk plants, particularly in the winter months, of immediately separating the milk and at once pasteurizing the cream before shipping it to the buttermaking plant. This practice has been found to aid in preventing long churning times, excessive foaming, and the rancid flavor of the butter.

Since normal raw cream contains a small amount of lipase it is possible that a part of the effect of pasteurization in shortening the churning time of normal cream is due to the destruction of lipase, particularly in view of the fact that the agitation of the raw cream in churning may greatly increase its activity.

The data of a third experiment in which the factor of ripening was introduced are presented in Table III. Fresh milk was divided into two parts. One part was pasteurized. Both were held at 5° C. for 24 hours and were separated at 20–25° C. in a small cream separator. The cream was standardized to 30 per cent of fat. One-half of the cream separated from the raw milk was inoculated with 1 per cent of starter and incubated at 18° C. for 18 hours, after which it was cooled to 0° C. for four hours prior to churning. The second part of the cream separated from the raw milk, as well as the cream separated from the pasteurized milk, was cooled and held at 5° C. for

TABLE II

Effect of pasteurization on the foaming and churning time of cream from the milk of cows in advanced lactation

Temperature of churning 14°–17° C. Cream 30 per cent fat.

COW	HEAT TREATMENT		CREAM HELD BEFORE CHURNING	ACIDITY AS LACTIC ACID CREAM	TIME OF CHURNING—MINUTES													
	Milk prior separation	Cream			10	15	20	25	30	35	40	45	50	55	60	65	70	75
					Per cent increase volume over that at the start													
No.			*hrs.*	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
4	Raw	Raw	24	.38	40	50	70	70	70	70	70	70	70	70	70	70	70	70***
	Raw	Raw	48	.45	50	70	70	70	70	70	70	70	70	70	70	70	70	70***
	Raw	*Heated	48	.30	40	40	40	40	40	40	40	40	40	40	40	40	40	40***
	Heated	none	24	.13	Butter													
	Heated	none	48	.13	Butter													
5	Raw	Raw	24	.195	50	50	50	40	20	Butter								
	Raw	**Heated	24	.....	20	20	Butter											
	Heated	none	24	.100	20	Butter												
	Heated	none	48	.....	20	Butter												
6	Raw	Raw	24	.22	40	40	40	40	Butter									
	Raw	Raw	48	.26	50	50	50	50	50	50	40	Butter						
	Raw	**Heated	24	.....	.....	Butter												
	Heated	none	24	.11	.....	Butter												
	Heated	none	48	.....	.....	Butter												
7	Raw	Raw	24	.15	.....	.....	.....	.....	.....	Butter								
	Raw	**Heated	24	.....	.....	.....	Butter											
	Heated	none	24	.09	.....	Butter												

* Standardized cream was held for 20 hours prior to pasteurization.

** Pasteurized immediately after separation.

*** Not churned at the end of 2 hours.

TABLE III

Effect of lipase activity on the churning time of ripened 30% fat cream

CREAM SEPARATED FROM	Pasteurized milk	Raw milk	Raw milk
Starter added	none	1.0%	none
Acidity before churning	.11	.28	.25
Churning time—minutes	24	42	60
Butter flavor	good	fair	rancid

the 22 hours prior to churning. Aliquots of 700 grams of each cream were measured into each of three glass churns surrounded by a water bath maintained at 15–16° C. After tempering for one hour the creams were churned. The data are presented in Table III. The cream from the pasteurized milk churned in the shortest time. The acidities of the two samples of raw cream were not greatly different. They differed greatly, however, in the types of acid present. The developed acidity of the sample to which the starter had been added was due largely to lactic acid, where as that of the sample to which no starter was added was due entirely to fatty acids liberated by lipolysis. Although evidence will be presented in a later paper by de Tomasi and Sharp it will aid in understanding this difference in acidity if it is mentioned that at this temperature range, with such cream, lipolysis is inversely proportional to the temperature, so that little lipolysis would occur at 18° C., while the action is very marked at 5° C. This difference is reflected in the churning time and the odor of the cream during churning.

The data in Table III show that the lipolysis which occurred while the milk was held cold before the cream was separated was sufficient to lengthen appreciably the churning time and even to counteract the shortening of the churning time which one would expect due to the development of acid.

Table IV gives an idea of the lipolytic activity of the different milks used. The increases in acidity are due to lipolysis and not to bacterial action. In general the relative differences in increase of acidity are correspondingly reflected by the lengthening of the churning times of the raw creams in Tables I and II.

As noted in Tables I and II the creams foamed greatly if appreciable lipolysis had occurred. The foam was of a different physical appearance from the foam usually formed in churning. The fatty acids and soaps probably displaced the normal foam constituents at the plasma-air interface, so that coagulation did not occur and the foam maintained its stability.

In churning raw cream from cows in advanced lactation we not only have the effect of the fatty acids which have been liberated at the time the churning is started, but we have an increase in fat hydrolysis during churning due to the accelerative action of shaking on lipolysis. Behrendt (1922) showed that shaking greatly accelerated the lipolysis of human milk but

TABLE IV

Increase in titratable acidity due to lipase action of samples of whole milk used in tables I and II

SAMPLES	FAT WHOLE MILK	PER CENT ACIDITY EXPRESSED AS LACTIC ACID		
		Hours held at 0° – 5°C.		
		0	24	48
	%			
1	7.4	.168	.195	.205
2	7.1	.170	.200	.260
3	4.0	.167	.185	.185
4	6.5	.180	.200	.225
5	4.8	.140	.....	.165
6	4.6	.160	.....	.205
7	3.5	.125	.....	.145

had no effect on lipolysis of cow's milk. We have found, however, that shaking does have a great accelerating effect on the lipolysis of raw milk from cows.

SUMMARY

1. The difficulty in churning and the abnormal foam formation found in cream obtained from the milk of cows in advanced lactation is probably due largely to lipolytic action and the concentration of the resultant soaps and fatty acids in the air-plasma interface.

2. Less difficulty in churning and less lipolytic action are encountered if the cream is separated while the fat globules are in a liquid state as contrasted to the solid state.

3. Pasteurizing the milk or cream as soon as drawn largely prevents the difficulty in churning.

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THE DIGESTIBILITY AND FEEDING VALUE OF RUSSIAN THISTLE HAY[1]

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INTRODUCTION

The Russian thistle (*Salsola testifer* Aven Nelson) is a summer annual herbaceous plant usually appearing in May or June. The young plants have slender, fleshy leaves and are grazed readily by cattle and sheep for several weeks, or until they become coarse and spiny.

The Russian thistle appeared in the United States in South Dakota about 1873 or 1874 (1), presumably being brought from Russia in flaxseed. Since its introduction it has spread over a large area in both the United States and Canada. It is very drought resistant and for this reason has made its greatest headway in semiarid regions.

Although called a thistle, due to the spiny tips on the leaves of the more mature plants, it actually belongs to the goosefoot family. Because of the fact that it commonly breaks loose from the ground and rolls long distances it is often called a tumbleweed. The plant puts out many branches near the ground level and as it matures these branches curve inward giving it a ball like shape. It has a small tap root which is easily broken loose by the wind after the plant matures. In the fall of a dry year it is not unusual to see piles of the plants several feet high drifted against the fence rows.

In size the Russian thistle plant varies from one to three feet in height and from one to five feet in diameter. It is estimated that one plant may bear as many as 200,000 seeds. As the plant rolls with the wind these seeds are sown over a wide area.

The Russian thistle is not normally a factor in Kansas either as a feed or a weed pest except in the western half of the state. For many years it has been used for both pasture and hay in that section during times of drought and feed shortage. This was especially true during the past year when many sections had no feed except Russian thistle. An estimate made in 50 western Kansas counties in October, 1934, indicated that there was available for feeding a total of about 400,000 tons of thistles. About nine-tenths of this was in the form of hay and one-tenth in the form of silage.

In chemical composition the Russian thistle varies widely, depending on the stage of maturity. The protein content is high compared with most non-legume roughages. A protein content of over 20 per cent (2) has been

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reported in young plants but the highest protein content of any sample analyzed at the Kansas Station during the past year was 14.87 per cent in hay cut late in July. Dry thistles collected along the roadway in late fall contained 6.25 per cent of protein. The ash content of the Russian thistle is particularly high, running from 13 per cent to as high as 30 per cent (2) with one-half or more of the ash consisting of potash and lime (3).

REVIEW ON LITERATURE

There appears to be no record in the literature of experimental trials having to do with digestibility of Russian thistles. Neither are there any data on the feeding value of the thistles when fed to dairy cows.

McCampbell (4) reported the results of a feeding trial conducted at the Fort Hays (Kansas) Branch Experiment Station in 1918–1919 where Russian thistle hay and alfalfa hay were used in maintenance rations for beef cattle. In this experiment approximately one-third of the dry matter of the ration consisted of hay and two-thirds of straw and silage. Under these conditions the thistle hay, which was of good quality, was the equal of alfalfa hay for beef cattle maintenance.

More extensive trials with thistles were conducted during 1934–1935 at the Fort Hays Station (5). It was concluded from these trials that ground Russian thistle hay alone is not a satisfactory wintering ration for stock cattle, but with the addition of 4 pounds of blackstrap molasses and 1 pound of cottonseed cake per head daily it makes an excellent wintering ration.

The thistle hay used in the Fort Hays trials was rather mature and varied in protein content from 5.13 per cent to 6.56 per cent.

At the Akron, Colorado, U. S. Field Station (6) in 1931–1932, Russian thistle hay was shown to have about the same feeding value as cane fodder for lamb feeding.

DIGESTION TRIAL

Experimental Methods. In the digestion trial conducted at the Kansas Station three dry cows were used, there being a representative each of the Ayrshire, Holstein, and Jersey breeds. The length of the trial was 25 days, divided into a 15-day preliminary period and a 10-day collection period. At first all the cows refused to eat the thistles so that it was necessary to use about 50 per cent alfalfa hay. The alfalfa was gradually reduced and none was fed after the fifth day of the trial. The hay used was cut in early August while still fairly green and was baled as soon as possible. A few of the bales showed a small amount of mold.

Approximately 1,000 pounds of ground Russian thistles were carefully mixed and sampled for analysis. From the remainder, 44 feeds for each cow were weighed into paper bags and sealed. The amount of thistles fed per day varied from 4,000 grams, fed to a 925-pound cow, to 7,000 grams,

fed to a 1,325-pound cow. The cows were weighed daily and it was interesting to note that these amounts of thistles maintained the cows at a remarkably constant weight. Two of the cows consumed all feed offered but one cow refused a small amount of dusty material for several feeds. The total of this refusal was 1,498 grams of dry matter.

During the collection period the feces from each cow were secured and stored in tight covered cans. At approximately 24-hour intervals this was weighed, thoroughly mixed and a $\frac{1}{10}$-aliquot sample taken. These daily aliquots were composited in tight covered cans and preserved with a small amount of chloroform. At the end of the 10-day collection period the composite samples were dried, ground and a uniform sample secured for analysis.

Results. The results of the digestion trial are contained in Table 1.

TABLE 1

Composition, digestibility, and digestible nutrients of Russian thistle hay

	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	ASH	N. FREE EXTRACT
Composition, per cent	86.22	9.25	0.96	22.50	15.65	37.86
Apparent digestibility, per cent	54.80	63.20	40.30	44.60		61.70
Digestible matter, lbs. per cwt.	47.25	5.85	0.39	10.04		23.36

The crude protein content of 9.25 per cent on the thistle hay used is high for a non-legume roughage but is much lower than that of alfalfa hay (7). The ash content of 15.65 per cent is higher than is found in most other roughages but the ether extract is very low. Most other samples of thistle hay on which analyses are reported, show a considerably higher fat content than did the hay used in this experiment. In crude fiber content the thistle hay used was lower than that of most dried roughages.

Although not as high as that of alfalfa the digestion coefficient of 63.2 for the protein of Russian thistle hay compares very favorably with that of most roughages. The digestibility of the crude fiber is approximately the same as that of alfalfa hay.

From the results of this digestion trial it appears that the Russian thistle hay used contained a total of 40.1 pounds of digestible nutrients per cwt. This was 80.5 per cent as much total digestible nutrients as that of the alfalfa hay used in the feeding trial.

MILK PRODUCTION TRIAL

Experimental Methods. In the milk production trial two lots of five cows each were fed by the double reversal method through three 30-day periods, the first ten days of each serving as a preliminary period. Each

lot contained one Guernsey, one Ayrshire and three Holstein cows and at the start of the experiment the average production per cow in each lot was approximately 35 pounds of milk daily. The sole roughage of the cows consisted either of ground alfalfa or ground Russian thistle hay.

Lot I was started on the thistle ration, and Lot II on the alfalfa ration. At the end of each 30-day period the rations furnished the lots were reversed. In addition to the hay, the cows while on thistles were fed a grain mixture of 2 parts ground corn, 1 part wheat bran, and 1 part choice cottonseed meal. Each cow also received 4 pounds daily of blackstrap molasses. This was added chiefly to increase the palatability of the thistles, although it also furnished considerable energy.

While on alfalfa hay the cows were fed a grain mixture of 4 parts ground corn and 1 part wheat bran. To each grain mixture was added 1 per cent of steamed bone meal and 1 per cent of salt. Each animal was fed according to her requirements as shown by the Morrison (8) standard.

Body weights were taken on three successive days at the beginning and end of each 20-day experimental period, the second of the three weight days falling on either the first or the last day of the period, as the case might be.

The milk from each cow was weighed and recorded at each milking. Samples were taken from the six milkings of each animal nearest the center of each 20-day experimental period and were tested for fat by the Babcock method. The average percentage of fat thus obtained was taken as the average for the period.

Samples of feeds for analysis were secured during each period. A sample of hay was composited from each lot ground, a sample of grain from each batch mixed, and a sample of molasses was secured from the container.

Results. The results of the milk production trial are given in Table 2.

TABLE 2

Summary of Lots I and II—(Pounds per cow per period)

	BODY WEIGHT			FEED CONSUMED			MILK AND FAT PRODUCED		
	Start	Finish	Change	Grain	Hay	Molasses	Milk	Fat	4% F.C.M*
Alfalfa	1072	1071	−1	199.5	396.5		563.5	21.71	551.1
Thistles	1085	1089	+4	197.8	376.8	76.9	519.0	20.38	513.3
Increase			5						
Increase %			0.5						
Decrease				1.7	19.7		44.5	1.33	37.8
Decrease %				0.9	5.0		7.9	6.1	6.9

* F.C.M. = Fat corrected milk (.4M + 15F) Gaines, W. L. and Davidson, F. A. Relation Between Percentage Fat Content and Yield of Milk. Ill. Agr'l. Exp. Sta. Bul. 245.

The changes in body weight on the two rations were slight, there being a 1-pound loss per cow per period on the alfalfa rations as compared with

a 4-pound gain per cow on the thistle ration. In the consumption of feed the chief difference was in the molasses fed, as the cows on thistles received molasses while the cows on alfalfa received none. There was also a somewhat greater consumption of alfalfa hay than of thistle hay. However, this was not unexpected as an attempt was made to secure as much of the nutrients as possible from the hay portions of the ration and there was somewhat more refusal of thistle hay than of alfalfa.

The milk and fat production was rather consistently in favor of the alfalfa ration. The production of 4 per cent fat-corrected milk was 6.9 per cent less on the thistle ration than on the alfalfa ration.

Table 3 furnishes some information on the digestible nutrients consumed from the two rations.

TABLE 3

Nutrients consumed per cow per period and the percentage of the total furnished by the different ingredients of the ration

	ALFALFA RATION				THISTLE RATION			
	Dig. protein	% of total	T.D.N.*	% of total	Dig. protein	% of total	T.D.N.	% of total
	(lbs.)		(lbs.)		(lbs.)		(lbs.)	
Grain mix	16.4	27.9	153.4	43.7	28.3	55.5	145.7	42.5
Thistle hay	.....	.....	.....	.....	21.9	42.9	151.1	44.1
Alfalfa hay	42.4	72.1	197.4	56.3	.....	.....	.....	.....
Molasses	.....	.....	.....	.....	0.8	1.6	45.8	13.4
Total	58.8	100.0	350.8	100.0	51.0	100.0	342.6	100.0

* T.D.N. = Total digestible nutrients.

From Table 3 it is apparent that the alfalfa hay was much more of a factor in the ration, from a protein standpoint, than was the thistles, since alfalfa furnished 72.1 per cent of the total protein of the ration while the thistles furnished only 42.9 per cent of the total.

Alfalfa hay furnished 56.3 per cent of the total digestible nutrients of the alfalfa ration, while the thistle hay furnished 44.1 per cent of the total of the thistle ration. Due to the fact that the Russian thistle hay used had only a little over one-half as much digestible protein as did the alfalfa hay it was necessary to make up this protein deficiency with cottonseed meal in the grain mixture. The total digestible nutrients consumed from the thistle ration was only 2.3 per cent less than the total digestible nutrients consumed from the alfalfa ration.

During some preliminary palatability trials and for a complete period during the course of the experiment, milk from the cows receiving thistle hay was examined daily for odor and flavor. Although slight feed flavors were noted at times, there was no consistent effect of the ration upon either the odor or the flavor of the milk produced.

Although a laxative action of Russian thistles is often mentioned by stockmen whose animals were receiving this feed, no such action was noted during this experiment either when the diet consisted wholly of thistles or where thistles furnished the roughage portion of the ration.

SUMMARY AND CONCLUSIONS

The Russian thistle hay used in these tests contained 62.1 per cent as much total protein, 55.2 per cent as much digestible protein, and 80.5 per cent as much total digestible nutrients as did the alfalfa hay used in the feeding trial.

Ground Russian thistle hay may be used with fairly satisfactory results to furnish 40 to 45 per cent of the protein and total digestible nutrients of a dairy cow's ration.

Alfalfa hay is a more satisfactory roughage for milk production than is Russian thistle hay. The thistle hay is much less palatable than is alfalfa hay and must be ground.

Russian thistle hay in the ration of dairy cows causes no appreciable off flavors or odors in the milk produced.

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American Dairy Science Association Announcements

ANNUAL MEETING, JUNE 16–19, 1936
STATE COLLEGE, PENNSYLVANIA

General Information

It is possible to announce at this time the general program for The American Dairy Science Association Meeting to be held the week of June 15 at The Pennsylvania State College. The College is preparing to entertain a large percentage of the members and their families. A detailed announcement and questionnaire concerning rooms will be sent to department heads about May 1. A program of entertainment for the wives, young people and children of members is being planned.

The members are reminded that titles of papers to be presented must be in the hands of S. I. Bechdel, Chairman of the Program Committee, by May 1st as per detailed announcement in the February issue of the Journal. Abstracts must be sent with titles by May 1st or very shortly thereafter if reprints of the abstracts are to be available for the members at the time of the meeting.

General Program

June 15—Monday

1 P. M.–9 P. M.	General registration and room registration, Dairy Building.

June 16—Tuesday

8 A. M.–9 P. M.	General registration and room registration, Dairy Building.
9 A. M.–12 Noon	Dairy Cattle Judging Conference.
12 Noon—1 P. M.	Lunch hour.
1 P. M.–4 P. M.	Extension Section Meeting.
1:30 P. M.–4:30 P. M.	Dairy Products Judging Conference.
7:30 P. M.	Opening session and Business Meeting, College Auditorium.
8:30 P. M.	Social get-together for members and their families, 2nd floor lounge, Old Main Building.

June 17—Wednesday

8 A. M.–12 Noon	General registration and room registration, Dairy Building.
9 A. M.–4 P. M.	Complimentary mountain tour for wives, young folks and children of members. See the mountain laurel in bloom and visit Alexander Caverns. Lunch at Greenwood Forest Camp. Tickets at registration.

8 A. M.–9 A. M.	Sectional Committee meetings.
9 A. M.–12 Noon	General Session, College Auditorium.
12 Noon	Complimentary Dairy Lunch, Dairy Building.
1 P. M.–4 P. M.	Sectional Scientific meetings.
4 P. M.–4:30 P. M.	Sectional Committee meetings.
4 P. M.–5 P. M.	See places of interest on College Campus. Respiration calorimeter, Jordan Fertilizer plots (oldest in America), mineral industries exhibit.
6:30 P. M.	Creamery Package Mfg. Company—Complimentary dinner for members and their wives. McAllister Hall. Tickets at registration.

JUNE 18—THURSDAY

8 A. M.–9 A. M.	Extension Exhibit.
9 A. M.–12 Noon	Sectional Scientific meetings.
9 A. M.–12 Noon	Children and young folks program—Supervised play, municipal playground, or mountain hike for those who prefer it.
10 A. M.	For Ladies—Places of interest on the Campus. Old Main Tower, Home Economics building, Mineral Industries exhibits, Rose gardens adjacent dairy buildings. Golf for those who prefer it.
12 Noon–1 P. M.	Lunch hour.
1 P. M.–2 P. M.	Sectional Business Meetings.
2 P. M.–4:30 P. M.	Scientific meetings—Extension, Manufacturing and Instruction sections.
2 P. M.–4 P. M.	Children and young folks program—Swimming at the Glennland Pool, finest in Pennsylvania. Admission by complimentary ticket. Exclusive use of pool reserved.
2 P. M.–4 P. M.	Entertainment for ladies at the Nittany Lion Inn.
6:30 P. M.	Subscription Banquet, McAllister Hall. (Tickets to be purchased at registration.)

JUNE 19—FRIDAY

8 A. M.–9 A. M.	General Business session.
9 A. M.–12 Noon	Scientific meetings—Manufacturing and Production sections.
12 Noon–1:30 P. M.	Lunch hour.
2 P. M.	Optional tours,—Kylertown pasture fertilizer project, Kylertown, Pa., Fisherman's Paradise, Pleasant Gap, Pa., U. S. Dairy Bureau farm, Beltsville, Md.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

X-ray Investigation of the Microcrystalline Structure of Butter-fat. W. Van Dam, Agr. Exp. Station, Hoorn, Holland; W. G. Burgers, Physical Lab. of the Philips Works, Eindhoven, Holland. Journal of Dairy Science *18*, 1, p. 45, Jan., 1935.

Butter was prepared from cream subjected to various temperatures before aging and the butter was also cooled at different rates and temperatures. X-ray interference exposures were made by the method of Debye-Scherrer.

It was found that the presence of liquid fat in the solid butter could be readily detected when the butter was made with some fats of high melting point. Crystallization of the butter fat during cold storage of the butter could be followed by X-ray analysis. The method did not show much difference between fresh butters made with normal and with very cold wash water.

The Use of Citric Acid and Sodium Citrate in Buttermaking. Hugh L. Templeton and H. H. Sommer, College of Agriculture, Madison, Wisconsin. Journal of Dairy Science *18*, 2, p. 97, Feb., 1935.

The work of numerous investigators has shown that the addition of citric acid to starter cultures increases the amount of the volatile products which are responsible for the flavor and aroma of the butter made from such starter cultures. The principal flavor and aroma constituents are generally conceded to be methylacetylcarbinol and its oxidation product diacetyl. It has been shown that the quantity of these flavor-producing substances may be increased as a product of the utilization of citric acid by lactic cultures.

Butter made from commercial starter cultures treated with 0.2 per cent of citric acid or its equivalent of sodium citrate at each transfer of the culture, and butters made with the same proportion of citric acid or sodium citrate added to the cream with the starter culture seemed to have a more desirable flavor and aroma than the butter made from cream without such additions. The increase in flavor and aroma was more noticeable when the citric acid or sodium citrate was added to both the cream and the starter culture rather than when added to the starter culture alone. Most of the treated butter showed excellent keeping quality. It was noted that the addition of the citric acid tended to decrease the fat losses in the buttermilk.

Investigations on the Keeping Quality of Butter. RUDOLF HEISS AND KARL ENGEL, Institute of Refrigeration Technique, Technical College, Karlsruhe, Germany. Milchw. Forsch. *17*, 1–2, p. 8, Feb., 1935.

When the air in cream was displaced by an inert gas and the butter was churned and stored in such gas, the keeping quality of the butter at low temperatures of storage was about three times as good as that for butter stored in air. At higher storage temperatures the influence of inert gas was negligible; hence cold storage cannot be displaced by storage-in-gas, but higher temperatures might be used economically. Butter stored in air at 0°C. (32°F.) kept as well as butter stored with nitrogen gas at 5–6°C. (41–42.8°F.)

The microflora was an important factor in deterioration as indicated by data obtained from casein agar platings. The relative humidity of the storage atmosphere was not a significant factor. The nature of the wrapping paper, whether genuine vegetable parchment, hydroloid paper, waterproof cellophane, pergamyn or imitation parchment, had no effect when the butter was stored in the dark. Suggestions are made concerning future commercial possibilities of the treatment of cream, churning and storage with inert gases and improvement in equipment, containers and sanitation.

CHEESE

On the Fat and Water Content of Cheese. A. BEYTHIEN, Dresden, Germany. Milchw. Forsch. *17*, 1–2, p. 1, Feb., 1935.

The author comments on the 1934 German laws and regulations governing cheese with special reference to fat and moisture content. The range in moisture contents of certain cheeses during 1932–1934 determined by the author were as follows: Brie 44.1–60.2 per cent; Camembert, full-fat 43.2–59.6 per cent; half-fat or skim 52.9–67.6 per cent; Altenburger Ziegenkäse, full-fat 48.1–62.7 per cent; half-fat or skim 62.0–73.1 per cent; Romadur 54.0–70.3 per cent; miscellaneous soft cheeses as Edel, Perle der Osmark, Feinkost, Dessert, Delikatess, Schloss and Alpen 47.7–70.9 per cent; Gervais 32.7–56.1 per cent; Roquefort 32.2–55.4 per cent; Neuschateller full-fat 51.9–67.0 per cent, half-fat 62.2–70.9 per cent; Holländer, full-fat 34.5–49.9 per cent, half-fat 41.4– 49.0 per cent; Schweizer 22.8–36.0 per cent, and Tilsiter, full-fat 31.0–52.0 and half-fat 39.1–55.5. The average moisture content seems to have increased in recent years and new problems have arisen in connection with process cheese.

On Spotted Cheese. W. GRIMMER AND J. RODENKIRCHEN, Dairy Institute, University of Königsberg, Germany. Milchw. Forsch. *17*, 1–2, p. 39, Feb., 1935.

The light, grayish-white spots or mottles appearing on cut surfaces of cheese are attributed to the oxidation of the vegetable cheese color, annato,

when potassium nitrate and large numbers of *Bacterium coli* (*Escherichia coli*), *Bacterium pyocyaneum*, (*Pseudomonas aeruginosa*) or *Bacterium vulgare* (*Proteus vulgaris*) are present.

Photometric Measurements of Butter, Butter Colors and Carotin. At the Same Time, a Contribution to the Question of Standardization of Butter Coloring. Fr. Richter, Institute of Animal Breeding and Dairying, University of Breslau, Germany. Milchw. Forsch. *17*, 1–2, p. 72, Feb., 1935.

The photometric measurements of five commercial butter colors (three chemical and two vegetable) showed large differences in concentration but only slight differences in the color comparison. The stability of the chemical colors, as determined by sensitivity to light, was superior to that of the vegetable colors. Carotin in an oil solution had somewhat poorer stability than the chemical colors but better than the vegetable colors. The color curves of butter colors and butterfat were decidedly different but between butterfat and carotin there was a marked similarity. Butter coloring studies showed the suitability of carotin for that purpose. The author proposes a fixed carotin content of butter, determined easily photometrically, as a scale for the standardization of the color of butter.

On the Detection of Preservatives in Process Cheese. G. Schwarz, Ottmar Fischer and O. Kahlert, Institute of Chemistry, Prussian Dairy Experiment and Research Institute, Kiel, Germany. Milchw. Forsch. *17*, 4, p. 170, Aug., 1935.

Three distinct and independent processes are described for the detection of benzoic acid in process cheese, namely, (1) microscopic observations of crystal formation, (2) microdetermination of the melting point and (3) specific color reaction. Photographs of apparatus and characteristic crystal pictures are presented. Benzoic acid was found in 22 of the 135 samples examined.

The Keeping Quality of Butter Depending on Different Packing Materials. A Contribution to the Question of Autoxidative Spoilage of Butter. F. Kierfle and A. Seuss, Chemical and Physical Division, South German Dairy Experimental and Research Institute at Weihenstephan, Technical College, Munich, Germany. Milchw. Forsch. *17*, 4, p. 181, Aug., 1935.

Ordinary commercial parchment paper, special parchment (Ultrament), parchment-like paper (Rowalin), tin and alumnium foil (lined and unlined, impregnated and plain), cellulose hydrate foil (colored and uncolored) were used for wrapping butter. The samples were exposed to the ultra-violet rays from a quartz lamp. The protection of the fat afforded by the wrapper

against the light was measured by a method for detecting the first stages of autoxidation with N/200 $Na_2S_2O_3$. Ordinary parchment was not as satisfactory as Ultrament, Rowalin, cellophane or metal foils.

CONCENTRATED AND DRY MILKS

Sauerkraut Juice for the Acidification of Evaporated Milk in Infant Feeding. C. V. Rice. Arch. Ped. *51*, p. 390, June, 1934.

Evaporated milk acidified with sauerkraut juice from tin containers has been found in a small series of cases to provide sufficient antirachitic factor to prevent or cure rickets in infants. Kraut juice from glass containers did not seem to provide the same protection. The author believes that the advantage of this form of acidified milk lies in the fact that the minerals and vitamins in sauerkraut juice are probably antirachitic and antiscorbutic, thereby eliminating the need for supplementary cod liver oil or orange juice. The formula is palatable, easily digested, economical and simple to prepare.

Color Development in Lactose Solutions During Heating With Special Reference to the Color of Evaporated Milk. B. H. Webb, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. Journal of Dairy Science *18*, 2, p. 81, Feb., 1935.

Reproducible color standards for measuring the color of lactose solutions in which heat has produced varying shades of brown have been described and defined in numerical terms according to the Munsell system of color measurement.

The presence of the phosphate radical in lactose solutions during heating has been shown to exert a specific effect in causing darkening in the color of these solutions.

Color development in lactose solutions during heating is increased with increasing concentration of hydroxyl-ions, lactose, amino acids, ammonium salts, phosphate and oxygen. The presence of copper or iron catalyzes the color reaction while tin retards color formation. A very small quantity of formaldehyde increases color while larger amounts markedly restrict color development. Sodium bisulfite will entirely prevent the appearance of color. When amino acids or proteins are present during heating, color is probably due both to the formation of a complex material formed from the lactose and an amino group and to a polymerization of the sugar to lacto-caramel. Either reaction may occur in the range of hydrogen-ion concentrations found in milk.

An effective means of preventing color development in lactose solutions during heating which would be suitable for use in improving the color appearing in evaporated milk during sterilization was not found. However,

the results obtained with lactose solutions substantiate the fact that the objectionable darkening in color of evaporated milk which occurs during storage can be materially lessened by shortening the storage period or lowering storage temperature.

On Dehydration and Hydrate Formation of Lactose. W. MOHR AND J. WELLM, Institute of Physics, Prussian Dairy Experimental and Research Institute, Kiel, Germany. Milchw. Forsch. *17*, 4, p. 109, Aug., 1935.

The water of crystallization of lactose was lost at 87° C. (188.6° F.) at an atmospheric humidity from about 3 grams per cubic meter or lower, while at 100° C. (212° F.) evaporation took place at a humidity between 8 to 14 grams per cubic meter. The lactose anhydride, water-free lactose obtained by dehydration at 100° C. (212° F.) in vacuum, proved decidedly hygroscopic at room temperature and ordinary atmospheric humidity and was converted back to the hydrate immediately. The evaporation of lactose solutions at 70° C. (158° F.) and 90° C. (194° F.) yielded thin layers of water-free lactose which was not hygroscopic in air at 20° C. (68° F.) with a humidity of 8 grams per cubic meter. This water-free lactose took up water over and above the amount necessary for hydrate formation only in air almost saturated with humidity (17 grams per cubic meter), and in storage at ordinary atmospheric humidity (5.2 grams per cubic meter) the water was given up almost completely. Longer storage in very moist air led to hydrate formation. The water contained in lactose "glass" was only absorbed since it was given up under conditions which do not permit the escape of the water of hydration. The alpha lactose hydrate and anhydride, ten minutes after dissolving, showed practically the same specific rotation of +82.2° and +79.6° while the lactose and lactose "glass" obtained in a thin layer from solution at 70° C. (158° F.) and 90° C. (194° F.) showed +60.3°, +58.1° and +56.6°. The Debye-Scherrer X-ray diagrams of the lactose preparations varied as did those of the alpha hydrate and the lactose obtained in thin layers from solution. The alpha lactose anhydride gave a characteristic X-ray diagram. The lactose "glass" showed only a broad, indistinct interference ring and was solidified amorphously.

MILK

The Effect of Alfalfa Hay on Milk Flavor. EARL WEAVER, A. H. KUHLMAN AND E. L. FOUTS, Oklahoma Agr. Exp. Station, Stillwater, Oklahoma. JOURNAL OF DAIRY SCIENCE *18*, 1, p. 55, Jan., 1935.

A good quality of alfalfa hay was fed to cows just after milking and at varying intervals before milking. It was found that the alfalfa hay imparted a distinct flavor to the milk when fed from ½ to 1 hour before milking.

The intensity of the off-flavor varies with the quantity of hay fed. Milk from small Jerseys is affected more seriously than that from large Holsteins when the cows are fed the same quantity of hay. Aeration of the milk removes only part of the flavor imparted to it by the hay and cooling seems to be ineffective.

Significant Aspects of a Recent Official Survey Concerning the Household Use of Milk in Philadelphia. SENECA EGBERT, Univ. of Pennsylvania, Philadelphia, Pa. Amer. J. Pub. Health *25*, 7, p. 789, 1935.

A survey was made during the summer of 1934 by the Department of Agricultural Economics of Pennsylvania State College and the U. S. Department of Agriculture. Similar surveys were made in 1924 and 1929.

Records were obtained from 3,004 families residing in the city and from 409 in the suburbs. Daily average per capita consumption of fluid milk in the home decreased from 0.68 pints in 1929 to 0.60 pints at the time of this study. It is unlikely that the decline was as great as this, since a number of factors did not remain fixed. The weekly average per capita consumption for those families reporting purchase and use was 2.25 quarts of fluid milk, a little less than 5 ounces of butter, and a little more than 0.5 pint of ice cream. Only 92.3 per cent of the families purchased fluid milk and only 92.7 per cent bought butter. Almost 50 per cent of the families bought some condensed or evaporated milk and nearly 40 per cent purchased ice cream. The relation between milk consumption and factors such as nationality, per capita income and size of family is discussed.

From 80 to 90 per cent of the chidren between the ages of 1 and 10 years drank milk regularly; at from 9 to 10 years there was a decline; and from 9 to 11 years there apparently was a decline in the percentage who drank milk habitually and a corresponding increase in the percentage who never drank milk. Thirteen per cent of children under 12 years, 30 per cent of adolescents between 12 and 18, and 83 per cent of mothers only occasionally or never drank milk. Generally speaking, the number of people who regularly drink milk has continued to increase during the last 10 years. Credit is given to organizations and agencies stressing the use of milk, and need for further work is indicated.

On "Milking Through" Cows, the Qualities and Composition of Their Milk and the Adaptability of an Austrian Alpine Breed for the "Finish Milking" Industry. WOLFGANG SCHEIMPFLUG, Institute for Dairy and Agricultural Bacteriology, College of Agriculture, Vienna, Austria. Milchw. Forsch. *17*, 4, p. 118, Aug., 1935.

The practice of continuing cows in production beyond their normal lactation period is common abroad. Certain establishments milk the cows as long as possible. Statistics are given for 5,192 animals and show that the Monta-

foner and Oberinntaler cows milked the longest; the Simmentaler, Unterinntaler and Pinzgauer next; and the Niederungsvieh and Blondvieh the shortest time. Data are also reported on a few Landschlag (Schecken), Tux-Zillertaler and Meraner cows. The Oberinntaler breed, besides its long and high milk productivity, is also low in original cost and more resistant to disease. The experimental animals were divided into two groups, with four cows in each group, the control consisting of animals which had calved from one to three months previously while the other group included cows that had been in milk for four to seven years. Data are given in detail on milk production, fat percentage, size of fat globules, creaming ability, specific gravity, total dry matter, fat-free dry matter, viscosity, lactose, protein, conductivity, calcium, chlorine, potassium, sodium, phosphoric acid, acidity, freezing point depression, rennet coagulability, total bacterial content, acid formers, *E. coli*, anaerobic spore-formers, reductase, Schardinger ferment, and diastase. The differences between the groups are not significant in most cases.

Wooden Milk Container and its Usefulness for Transport. HUGO KÜHL, Berlin, Germany. Milchw. Forsch. *17*, 4, p. 99, Aug., 1935.

A new type of oaken vessel for transporting milk is described which the author claims is preferable to tinned iron cans, especially as regards the effect on milk.

Relation of the Retail Price of Milk to Production Costs. THOMAS PARRAN, JR., State Health Commissioner, Albany, N. Y. Amer. J. Pub. Health *25*, 3, p. 239, 1935.

The legislature of New York made the Health Commissioner an *ex-officio* member of a milk control board established in 1933. A statistical study is presented of production costs, utilization of milk, variation in efficiency of operation of dealers, and distributors' costs. The author claims that state regulation is of value to the producer. The conclusion is drawn that if substantial reductions in the cost of milk to the public are to be made, they must be accomplished through more efficient operations or the elimination of expensive services.

Nutrition and Health and the Price of Milk. JAMES A. TOBEY, The Borden Company, New York, N. Y. Amer. J. Pub. Health, *25*, 2, p. 197, 1935.

Although milk is recognized as our most important food, the consumption in this country is now far below the acknowledged standards of an adequate diet. The consumption of milk in the United States should be increased at least 70 per cent. The beneficial effects of greater milk consumption upon physical welfare, the factors influencing consumption and the price of milk

are discussed. The economy of milk as a food is compared to that of other foods. At its present price or even at double that price, milk gives a better return on the nutritional investment than any other food. In the author's opinion, the solution of the economic problem of the dairy industry is not through a decrease in production, but by an increase in consumption of milk and dairy products, an endeavor which deserves the active cooperation and assistance of all public health officials.

The Proper Filling and Capping of Sterilized Bottled Chocolate Milk. A. H. WORTH, Chemical Director, Crown Cork and Seal Co., Baltimore, Md. The Dairy World, *14*, 1, p. 51, June, 1935.

In the bottling of chocolate milk which is to be sterilized (usually for 17–19 minutes at 235°–240°F.) it is necessary to allow sufficient "head space" under the crown seal and above the liquid to provide for expansion due to the heating. The amount of space required will vary with the filling temperature, being greater where the milk is filled cold and less where the milk is filled hot. A table is given showing the coefficient of expansion for water and for chocolate milk and the volume occupied by 1 gram of chocolate milk at various temperatures.

If sufficient head space is not provided in filling the bottles or in choosing a proper bottle size, then there will be a high loss in sterilizing due to blown off caps and burst bottles. A safety factor above the minimum actually required of about 0.2 fluid ounces (regardless of bottle size) is suggested.

For the sealing of chocolate milk bottles a cap, made of tin of similar metal fitted with a cork ring capable of holding 70 pounds pressure, is suggested. These caps are now available in disc form, stacked in tubes and are formed over the lip of the bottle by an automatic capping machine which gives the appearance of a preformed crown on the capped bottle.

A Chart to Aid in Scoring Milk Flavor. E. L. FOUTS AND EARL WEAVER, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma. JOURNAL OF DAIRY SCIENCE *18*, 1, p. 51, Jan., 1935.

A chart has been devised to assist persons scoring milk for flavor to ascribe some numerical significance to different gradations of a defect. Three degrees of intensity are used to describe any flavor defect, the terms "slight" and "very" being employed to reveal the upper and lower gradations in the flavor. A definite numercial range is assigned to each class. In this manner the chart aids materially in standardizing the numerical scoring of milk for flavor.

The Temperature of Milk Immediately after Milking and Strainer Capacity. A. C. DAHLBERG AND H. L. DURHAM, New York Agr. Exp. Station, Geneva, N. Y. N. Y. Agr. Exp. Station Bull. No. 639, Jan., 1934.

Comparisons were made between the temperature of hand-milked milk and milk drawn with two different milking machines. It was found that the temperature of milk is dependent upon the temperature of the barn, the total weight of milk given by each cow, and the method used for milking. Because strainer capacity is so dependent upon milk temperature, variations in strainer capacity may be attributed to one or more of the above mentioned factors.

This study showed that milk drawn by hand from heavy producing cows in warm barns had the highest temperature and strained the fastest.

How to Keep the Growing Child Interested in Milk. H. K. DUGDALE, Vice-Pres., Van Sant, Dugdale and Co., Inc., Baltimore, Md. Dairy World, *12*, 10, p. 20, March, 1934.

Contests to exemplify excellency in athletic or physical training in connection with the school work of children is recommended as a means of increasing the consumption of milk. The plan calls for prizes to be awarded to the boys or girls with the highest marks, and who present with their athletic or physical training grade certificate a statement signed by their parent or guardian that they drink milk with every meal.

Such contests link the drinking of milk with outstanding athletic performance, and during the period of the contest and for years afterward those school children participating, and even those who do not, will hold this thought embedded in their minds.

The Cost of Producing Milk in Rhode Island. J. L. TENNANT, Rhode Island Agr. Exp. Station, Kingston, Rhode Island. Rhode Island Agr. Exp. Sta. Bull. 241, Jan., 1934.

The average cost of producing 100 pounds of milk on 39 Rhode Island farms during the 12 months from February 1, 1932, to January 31, 1933, was given.

Milk Distributors' Costs and Profits in New York State. LELAND SPENCER, N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y. Milk Dealer, *23*, 2, 3, 4, p. 43, p. 35, p. 31, Nov., Dec., 1933, Jan., 1934.

This is a preliminary report to the New York State Milk Control Board based on returned questionnaires from 30 distributors in New York City and from 29 distributors in the upstate cities.

These questionnaires called for sales, costs, and profits in the months of June, July, and August, 1933, and for balance sheet information as of De-

cember 31, 1932. Comparative operating figures for June, July, and August, 1932, and balance sheet information for December 31, 1931, also were requested.

A total of 10 tables of figures are presented. This data is in the form of averages for groups of companies. A wide variation existed among the several concerns, however, for example, the amount of profit or loss per quart of milk in August, 1933, varied among the New York companies from a profit of $.0035 to a loss of $.0128. Among the distributors doing business in the larger upstate cities, the net profit or loss per quart varied from a profit of $.0105 to a loss of $.0165.

Committee comments: The complete publication upon which these articles are based is the Report of the Joint Legislative Committee to Investigate the Milk Industry, Legislative Document No. 114 (1933, pp. 473).

An Analysis of the Fresno Milk Market. J. M. TINLEY, Univ. of California, Agr. Exp. Station, Berkeley, California. California Agr. Exp. Sta. Bull. 559, Oct., 1933.

The purpose of this study was to analyze the economic factors affecting the long-time stability of the Fresno milk market and to ascertain possible means of affecting economies through reorganization of present methods of handling milk in Fresno. Data were secured from dealers, producers, the State Department of Agriculture, and the Fresno Health Department. Twenty-three tables of data are presented in this comprehensive study of 59 pages.

Laboratory Examinations of Milk Handlers. EARLE K. BORMAN, D. EVELYN WEST AND FRIEND LEE MICKLE, Conn. State Dept. of Health, Hartford Conn. Amer. J. Pub. Health, *25*, 5, p. 557, 1935.

Based upon statistics for the entire United States from 1880 to 1933 and for Connecticut from 1918 to 1933, the epidemiological importance of milk-borne diseases traced to human carriers and cases is discussed. The necessity for remedial measures to control milk-borne infections is indicated.

Opinions were obtained from 205 persons in authoritative positions on the value of routine laboratory examinations of specimens from milk handlers; also comments of these officials concerning the value of the Connecticut program are recorded. The conclusion is made that periodical physical examinations of milk handlers supplemented by certain routine laboratory tests are desirable for the handlers of raw milk and for the employees in pasteurization plants. The total actual cost of 24,487 laboratory examinations in Connecticut in 1933 was $7,966.

The laboratory examinations discussed are: Throat and nose cultures for virulent diphtheria organisms and for beta hemolytic streptococci, sputum for *Mycobacterium tuberculosis;* feces and urine for typhoid, paratyphoid,

dysentery, and food poisoning bacteria; Widal tests; feces for vegetative or encysted forms of *Endamoeba histolytica*. The role of the laboratory in a complete routine examination of milk handlers is discussed and a program suggested.

A Modified Technic for the Detection of the Escherichia-Aerobacter Group in Milk. ANDREW MOLDAVAN, Guaranteed Pure Milk Co., Lt., Montreal, Que., Canada. Amer. J. Pub. Health, *25*, 9, p. 1932, 1935.

The use of agar-sealed fermentation tubes is described. Into ordinary test tubes are placed 9 cc of 2 per cent brilliant green lactose peptone bile and sterilized. The medium is inoculated with 1 cc of milk, the tube is rolled between the hands to insure a uniform distribution of the inoculum, and 2 cc of 2 per cent agar are poured slowly along the side of the tube where it cools rapidly and forms a solid plug. The following advantages are claimed: (1) Results are positive or negative for 1 cc of milk, whereas, when small inverted gas tubes are used, the amount of milk introduced into the small tube varies from 0.1 to 0.5 of inoculum. (2) Traces of gas are more noticeable in agar-plugged tubes than in submerged and inverted tubes. (3) In positive samples, gas will be detected within 8–16 hours in agar-plugged tubes, whereas the inverted tube technic requires a 48-hour incubation period.

Acidophilus Kefir, Composition and Bacterial Flora. O. K. PALLADINA, T. A. KROTOVA AND W. A. MASJUKEWITSCH, Dairy Lab., National Institute of Nutrition, Leningrad, U.S.S.R. Milckw. Forsch. *17*, 1–2, p. 25, Feb., 1935.

A satisfactory and uniform kefir can be prepared by using mixtures of selected pure cultures (70 per cent symbiotic streptococci, 25 per cent *Lactobacillus acidophilus* or *L. caucasicus* and 5 per cent lactose-fermenting yeasts). Total and volatile acidity, diacetyl, alcohol from milk and carbohydrates and proteolysis caused by various bacteria, with and without symbionts and/or yeasts, are reported as well as the comparison of kefirs produced by various cultures.

Investigations of the Actions of Microorganisms on Milk. CONSTANTINO GORINI, Director, Bacteriological Lab., Royal Agr. College, Milan, Italy. Milchw. Forsch. *17*, 4, p. 87, Aug., 1935.

In studying the coagulating and digesting activities of bacteria on milk, the author used a method of flooding the surface of inoculated agar plates with sterile milk. He used 115 cultures of pathogenic streptococci (16 species), 33 cultures of mastitis streptococci, 22 cultures of *Bact. typhi flavum*, a yellow variant of the typhoid bacillus and 8 variants of *Eberthella typhia*. The detection of the enzymes, chymase (coagulating) and protease

(digesting) was much more satisfactorily accomplished by this procedure than by the more common methods. The author suggests that the results obtained may have a bearing upon the interpretation of relationships or differences between various species or strains of bacteria.

Influence of Salt on the Growth and Cell Form of Lactic Acid Bacteria, *E. coli*, *A. aerogenes* and some other Common Milk Bacteria. W. HENNEBERG AND HANNA KNIEFALL, Institute of Bacteriology, Prussian Dairy Experimental and Research Institute, Kiel, Germany. Milchw. Forsch. *17*, 4, p. 146, Aug., 1935.

The effect of sodium chloride on the growth and morphology of 68 cultures of common milk bacteria was studied. Milk, lactose agar, and china blue lactose agar were used as substrates. The growth in the different media and at different salt concentrations varied with the different strains and species. Each culture showed distinct and individual responses to the environment. Variations in growth rates or morphology taking place in dairy products such as butter and cheese where salt is a factor, and the interpretation of microscopic pictures of storage are very significant. The observations made by the authors should be very helpful to those investigators interested in the microbiology of dairy products.

Studies on Lactic Acid Streptococci. V. On the constancy of fermenting power of fecal streptococci in many years of milk culture. KARL J. DEMETER AND R. PFUNDT, Bacteriological Section, South German Dairy Experimental and Research Institute, Weihenstephan Technical College, Munich Germany. Milchw. Forsch. *17*, 1–2, p. 44, Feb., 1935.

Nine cultures of lactic acid streptococci of fecal origin were studied after more than eight years of cultivation in milk in order to determine the constancy of their fermenting power, especially for carbohydrates. The same media and methods used eight years previously were employed. No noteworthy change in fermenting capacity was observed. Apparently milk is an excellent medium for the preservation of cultural and biochemical characteristics of these fecal streptococci. The close affinity of *Streptococcus faecalis* and *S. lactis* is suggested.

On a New Execution of Roll Tube Culture and its Usefulness for the Determination of the Germ Count in Milk. HELMUT DAMM. Institute of Bacteriology, Prussian Dairy Experimental and Research Institute, Kiel, Germany. Milchw. Forsch. *17*, 1–2, p. 51, Feb., 1935.

A modification of the Esmarch roll culture method is described and the apparatus illustrated. Statistical analyses of data obtained by this new

rapid method are reported and indicate that it has an advantage over the Burri method and compared more closely with standard plate methods.

Studies of Correlated Human and Bovine Brucelliasis. Statistical and Serological. R. V. STONE AND EMIL BOGEN, Los Angeles, California. Amer. J. Pub. Health, *25*, 5, p. 580, 1935.

An attempt was made to determine the incidence of infection with *Brucella abortus* among persons consuming raw milk from three herds supplying three institutions for the cure of tuberculosis patients in Los Angeles County.

The incidence of infection of the cattle varied from 6 to over 50 per cent, as revealed by agglutination titers of 1/50 or higher, with an average of nearly 30 per cent showing agglutination in titers of 1/100 or higher.

During the first half of 1930, more than 1,200 specimens of blood were taken from patients of these three institutions and tested for agglutinins of *Br. abortus* by the macroscopic method recommended by the University of California Committee. The results indicated that the ingestion of raw milk obtained from cows infected with contagious abortion and showing positive tests for agglutinins to *Br. abortus* in their blood is responsible for the development of similar agglutinins in the blood of some consumers. This occurred in about 8 per cent of those continuously exposed to the ingestion of heavily infected raw milk, but varied with duration of exposure, amount of infection in the herd and amount of raw milk consumed. Tuberculosis or other disease apparently had no effect upon the development of such agglutinins except in so far as they might affect the amount of milk consumed. The development of such agglutinins was not found to exercise any marked effect on the course of the tuberculosis. More than half of the patients developing agglutinins to *Br. abortus* gave no other manifestation of the infection. About one-eleventh of them manifested clinical symptoms warranting a diagnosis of undulant fever.

Standardization of the Methylene Blue Reduction Test by the use of Methylene Blue Thiocyanate. H. R. THORNTON AND R. B. SANDIN, University of Alberta, Edmonton, Alberta, Canada. Amer. J. Pub. Health, *25*, 10, p. 1114, 1935.

It is difficult to duplicate the standard tablets of methylene blue certified by the Commission on Standardization of Biological Stains if the methylene blue salt used is to be the methylene blue chloride. Joint studies by a number of laboratories in the United States and Canada of samples of methylene blue thiocyanate distributed through the chairman of the Commission on Standardization of Biological Stains have shown that the thiocyanate and chloride of methylene blue are identical in their reducing properties.

It is recommended that (1) methylene blue thiocyanate be substituted

for methylene blue chloride in the standard tablets used in the methylene blue test because of the reproducibility of the former dye, and that (2) one part of dye to 300,000 parts of milk be adopted as the standard concentration in this test.

An Outbreak of Milk-borne Hemolytic Streptococci Infection. ARTHUR W. NEWITT, JEAN W. GLASSEN AND R. W. PRYER, Michigan Department of Health, Lansing, Mich. Amer. J. Pub. Health, *25*, 7, p. 804, 1935.

An outbreak of sore-throat in Petersburg, Michigan, during September, 1934, was traced to the use of raw milk. There were 186 known cases and 6 deaths. The attack rate was 28.6 per 100 inhabitants, while the fatality rate was 3.22 per 100 cases. The outbreak was caused by the transmission of hemolytic streptococci from an infected quarter of one cow which was probably infected by a hemolytic streptococcus of human origin. None of the cultures from the milk or human throats was entirely characteristic of *Streptococcus epidemicus*. The disease produced by the Petersburg strain differed materially from scarlet fever in its usual clinical manifestations and more nearly resembled typical sore throat.

Evidence that the infecting organism was a variant rather than a fixed strain of scarlet fever streptococcus is presented.

Media Suggested as Substitutes for the Standard Agar used in Routine Milk Control Work. ROBERT S. BREED, New York Agr. Exp. Station, Geneva, N. Y. J. Amer. Pub. Health, *25*, 5, p. 663, 1935.

Bacteria that do not grow readily on the ordinary standard agar are frequently present in milk samples and may cause gross errors in bacteria counts. The formula of two agars that have been suggested as substitutes for the present standard nutrient agar are a Tryptone glucose skimmilk agar developed by Bowers and Hucker in this country, and an English modification of standard agar primarily developed at the Dairy Research Institute, Reading, England, and in the laboratories of the United States Dairies, London, England. The composition of the Tryptone glucose skimmilk agar is Tryptone 5 grams, glucose 1 gram, agar 15 grams, fresh skimmilk 5 cc and distilled water 1,000 cc. The English modification of standard agar consists of adding 5 cc of good quality skimmilk per 1,000 cc of sugar just before autoclaving. Detailed directions are given for the preparation of these two media.

Isolation of Streptococci from Milk. WILLIAM M. GROESBECK, Steuben County Laboratories, Hornell, N. Y. Amer. J. Pub. Health, *25*, 3, p. 345, 1935.

The isolation of streptococci from milk is frequently difficult because of the presence of other bacteria. The author adopted a technic for use in

milk analysis which previously has been used by other workers for determining the streptococcus content of feces. This method is most satisfactory with composite or herd samples.

While 1 cc of a thoroughly mixed sample may be used, preferably 1 cc of the gravity cream is emulsified in a test tube containing 10 cc of a freshly prepared sterile 1 per cent solution of sodium carbonate of tested purity. When the mixture is incubated at 37° C. over night, growth of the streptococci occurs and gram negative bacilli are destroyed. Sub-cultures from the carbonate solution are then made upon blood agar plates and the isolation completed in the usual manner.

Undulant Fever. Lancet, *228*, p. 145, June 22, 1935.

The Lancet discusses editorially the prevalence of undulant fever and the importance of more adequate diagnosis and control, with particular reference to the paper by Beattie, Smith and Tulloch. Methods of treatment of the disease have been rather unsatisfactory, on the whole, although certain investigators support the use of various vaccines. The value of pasteurization in the prevention of undulant fever is shown by the fact that wherever pasteurization is compulsory cases of this disease are never traced to the milk.

An Investigation of Kuban Fermented Milk. V. M. Bogdanoff, Dairy Prod. Res. Inst., Moscow, U. S. S. R. J. Dairy Res. *5*, 2, p. 153, April 1934.

A study was made of Kuban fermented milk (Kuban being adjacent to the district of Don in South Russia).

Microscopic examination of the curd showed organisms of the following types: (1) granular rods of varying length, (2) streptococci, appearing mostly as diplococci, and (3) yeasts. The streptococci and rods predominated.

As a means of isolating the two former organisms, inoculations were made on plates of the following media: (1) beef peptone, (2) whey agar, and (3) milk-peptone gelatin. As has been previously observed with lactobacilli, neither organism manifested any growth on the first medium, while both showed poor growth on the whey agar. On milk-peptone gelatin both organisms formed normal colonies. In addition to the above inoculations, the Kuban fermented milk was plated on malt agar. From these plates three separate species of yeast were insolated, which could be distinguished from one another partly by their morphological and partly by their physiological characters.

The following summary is given:

1. Kuban fermented milk is characterized by two types of fermentation, *i.e.*, lactic acid fermentation and alcoholic fermentation.

2. The micro-flora of such milk always embrace the following components:

(a) a lactic acid producing streptococcus resembling *Str. hollandicus;* (b) a lactic acid producing rod of the type of *L. bulgaricus;* and (c) three types of yeast.

3. There is close symbiosis between the component organisms. The two lactic acid producing organisms can function normally in the absence of the yeasts. The latter, however, prolong the vitality of the starter and also impart a specific taste to the fermented milk.

Inoculation of the natural starter with *Str. lactis* results in a rapid multiplication of this organism and an overproduction of acid, which imparts to the fermented milk the taste of ordinary sour milk. A similar undesirable taste is produced if the fermented product is prepared from raw, instead of heated, milk.

Has Sanitation of Certified Milk any Practical Value? C. E. NORTH, New York City, Certified Milk, *9*, 93, p. 3, and 94, p. 6, 1934.

In an effort to determine whether or not the sanitary precautions required for the production of high grade milk has any value other than esthetic, the author supervised the analyses of various grades of milk sold in Boston, New York, Philadelphia and St. Louis. The test employed consisted of heating the milk to be tested to 82.2° C. (180° F.) for 10 minutes then cooling to about 38° C. (100° F.). Twenty-cubic centimeter samples were then placed into each of ten Smith fermentation tubes and incubated at 37° C. (98° F.). Observations after 6 to 48 hours showed the presence or absence of spore forming types which induced either proteolysis or the formation of gas. The former types come largely from hay, barn dust and utensils, the latter from fecal contamination. Some evidence is available to show that proteolytic types may also be of intestinal origin.

With a few exceptions milk produced under the conditions of certified milk showed no fermentation in any of the ten tubes after 24 hours; Grade A milk rarely showed more than one tube in ten with gas after 24 hours, whereas ordinary market milk usually showed from five to ten tubes with gas in 10 to 18 hours.

The organisms responsible for this gas fermentation are considered to be *B. Welchii* which are intimately associated with intestinal inflammation, diarrhea, fever, nausea, jaundice and other complications of infant consumers of the milk.

Prevention and Eradication of Bang's Disease. W. W. DIMOCK, Kentucky Agr. Exp. Station, Lexington, Kentucky. Kentucky Agr. Exp. Sta. Cir. No. 41, Jan., 1934.

This circular discusses practical methods for the eradication of contagious abortion.

The New Method of Plate Count. HUGO JONE, Formerly Chief Chemist and Bacteriologist, Empire State Dairy Co., Brooklyn, N. Y. Amer. Creamery and Poul. Prod. Rev., *78*, 7, p. 222, 1934.

The author states that plate counts on pasteurized milk made according to the procedure in "Standard Methods" are generally too high, when compared with the plate count on the corresponding raw milk. This is due to the fact that most of the lactic acid forming bacteria are destroyed during pasteurization, while in raw milk the lactic colonies do not fully develop at an incubation temperature of 37° C. for 48 hours.

This error may be corrected by incubating as directed under the heading "Verification Methods,"* namely at 20° C. for 72 hours, and at 37° C. for 48 hours. The two incubations would be used jointly in the two tests.

Studies on the Leucocyte Content of Milk Drawn from *Brucella abortus* Infected Udders. C. C. PROUTY, Washington Agric. Exp. Station, Pullman, Washington. J. Bact. *27*, 3, p. 293, 1934.

A study was made of the leucocyte content of the milk from 18 abortion-infected cows in relation to the presence of *Br. abortus* within the udder. Of the 72 quarters, 21 were found by cultural methods to harbor the specific organism, and in the remaining 51 quarters negative cultural findings were obtained. The leucocyte counts of the milk from the 21 infected quarters and the 51 non-infected quarters were 355,000 and 343,000 respectively. If the high leucocyte counts from two streptococcus mastitis cases were omitted, averages of 145,000 and 185,000 respectively were obtained. Similar average leucocyte counts were obtained from a study of samples collected from an abortion-free herd. The conclusion is drawn that there is no significant difference in the leucocyte counts of milk from *Br. abortus* infected udders and of milk from animals free from the disease.

All samples of milk negative for agglutination reactions in amounts of serum less than 0.08 cc. gave negative cultural findings for *Br. abortus*.

Passage of Bovine *Brucella* through Swine. H. L. GILMAN, C. H. MILKS, AND R. R. BIRCH, Cornell University, Ithaca, N. Y. J. Infect. Diseases, *54*, 2, p. 171, 1934.

Although the organisms responsible for undulant fever, malta fever in man, and abortion in cattle and goats have been arbitrarily classified according to their origin and certain biochemical characteristics, the exactitude of the methods of differentiation have never been uniformly successful. There has been some question as to whether a strain ordinarily classified as a bovine type might be transformed to a porcine type by inoculation and growth in swine.

* Committee comments: These methods, described on pp. 42–43, Standard Methods of Milk Analysis, 6th edition, 1934, call for incubating plates at 20° C. for 72 hours, and at 55° C. for 24 hours.

An attempt was made to determine whether the passage of bovine strains of Brucella through a series of sows would induce these strains to assume the characteristics of the porcine type as determined by the usual dye-tolerance tests. One strain was passed through a series of two hogs; two strains through two series of five hogs each, and one strain through a series of six hogs. At no time was there any evidence of a transformation of the bovine type to the porcine type as determined by the reaction of the strains to the presence of basic fuchsin or thionine in the mediums in dilutions of 1: 50,000.

Undulant Fever in New York State. RUTH GILBERT AND MARION B. COLEMAN, State Dept. of Health, Albany, N. Y. Jour. Infect. Diseases, *54*, 3, p. 305, 1934.

Data accumulated during the past seven years indicate that cattle or dairy products are the source of the incitant in nearly all of the cases of undulant fever in New York State. In contrast to the conditions reported in certain European countries and in parts of the United States, infection from goats and hogs is apparently of negligible importance in New York. Blood specimens from 1290 cows and milk or cream from 383 cows have been studied. The milk and cream samples were from 68 herds which had been suspected of responsibility for known cases of undulant fever. Evidence of infection with the abortus-melitensis group was demonstrated in at least one animal, and usually in a considerable percentage, of them, in each of 56 herds. It is estimated that 18 per cent of the animals in the state are infected.

The incidence of undulant fever in New York is shown by the State Health Department records for 1930, 1931, and 1933 to be 165, 171, and 223 cases respectively.

There were 88 strains of the abortus-melitensis group isolated either from cow's milk or human blood. Each culture showed the usually accepted characteristics for the bovine strain.

Milk Control and Public Health. EDITORIAL. Amer. J. Public Health, *24*, 1, p. 46, 1934.

There is no real surplus of milk production in the country if the nutritional needs of the population are considered instead of the present paralysis of buying power which has reduced by 25 per cent the milk consumption in some areas. Governmental control of the milk production and prices will fall short of its potential good if advantage is not taken of the opportunity to promote the sanitary quality of the milk left on the market. Those concerned only with the economic aspect of milk control neglect the public health aspect. Health authorities thus far have had no voice in milk marketing agreements. The milk supply of most cities is not yet of a uniformly satisfactory sanitary quality. If there must be curtailment of production it

should be directed along lines which will eliminate the poor quality product and hence induce an increased consumption for the remainder. The elimination of tuberculosis cattle and of cows suffering from contagious abortion afford a good starting point in a curtailment program.

Bovine Tuberculosis in the British Isles. EDITORIAL. Amer. J. Public Health, *24*, 2, p. 142, 1934.

Reports from the Peoples League of Health show that during the years 1920–1931 there have been 25,166 human deaths in England due to the bovine tubercle bacillus. Approximately 40 per cent of the cattle of England are reactors to the tuberculin test and about 2.5 per cent are infective. Udder tuberculosis is most dangerous from the human standpoint but pulmonary tuberculosis is more important from the standpoint of spreading the disease among cattle. Confirming findings of earlier investigators the report concludes that infection of humans with bovine tuberculosis takes place mostly during the milk-drinking period of 1 to 5 years.

Similar studies in Scotland show that tuberculosis of bovine origin is even more wide spread. It is estimated that 70 per cent of the non-pulmonary tuberculosis patients become infected prior to 15 years of age, and that in 90 per cent of these either bone, joint or abdominal tuberculosis becomes manifest. It is estimated that 80 per cent of the abdominal, 35 per cent of the bone and joint, and 64 per cent of the cervical gland tuberculosis in Glasgow, Scotland is of bovine origin.

Further Investigations on the Determination of the Hydrogen Ion Concentration of Milk by the Colorimetric Method. G. SCHWARZ AND OTTMAR FISCHER, Institute of Chemistry, Prussian Dairy Experimental and Research Institute, Kiel, Germany. Milchw. Forsch. *17*, 4, p. 158, Aug., 1935.

Instead of the usual color standards of inorganic buffer solutions, milk sera are prepared by using normal sweet milk, to which increasing amounts of sour milk are added to give milks of varying acidity. The samples are treated with methanol (20 ml. milk to 30 ml. methanol), placed in the refrigerator for 30 days and then filtered. The pH of each serum is then determined electrometrically, indicator is added, and the sera are placed in sealed, glass tubes to fit in a color comparator as standards. These standards are good for six months. The indicator solution consists of 20 milligrams brom cresol blue, 50 milligrams methy red and 100 milligrams brom cresol purple dissolved in 1000 milliliters neutral methanol. To each 10 milliliters of serum, 1 milliliter of indicator is added. Samples of sera to be tested are prepared with methanol in the manner indicated above. Measurements can be made with an accuracy of about 0.1 pH within limits of pH 5.6–6.7.

A Gravimetric Micromethod for the Determination of Milk Fat and Dry Matter. G. Gorbach and R. Kadner, Biochemical Institute, Technical and Mining College, Graz-Leoben, Graz, Austria. Milchw. Forsch. *17*, 4, p. 190, Aug., 1935.

A new apparatus is described and pictured for the micro-determination of milk fat and dry matter by ether extraction. The method is much faster than macromethods with a Soxhlet extractor. The maximum error was 0.07 per cent for fat content, but somewhat greater for dry matter.

Twin Pots of Gold. Esther Martin, Nutritionist, National Dairy Council. National Butter and Cheese Journal, *26*, 24, p. 10, 1935.

Per capita consumption of cheese in the United States is compared with that of certain European countries. Some of the literature on the nutritive value of cheese is reviewed to show that although the food value of cheese varies with its compostion and its method of manufacture, still the common varieties are high-energy foods and excellent sources of protein, calcium, phosphorous, and vitamin A. Pleasing and distinctive flavors of cheese have a favorable effect on its digestion.

An Experiment in First Class Protein. Corry Mann—with introduction by F. Gowland Hopkins. Lancet, *228*, p. 145, Jan. 19, 1935.

In introducing Dr. Corry Mann, Sir F. Gowland Hopkins points out that it has been generally accepted that animal proteins are superior to vegetable proteins in human nutrition. The study conducted by Dr. Mann on himself is interesting and points to a need for further controlled studies along similar lines.

The study described was undertaken to determine the minimum protein requirements for an adult, and also to discover the relative efficiency of milk protein compared with other forms of protein. A basal diet composed of 2191 calories, providing 52.88 grams of animal protein (70 per cent of total protein), and including 21 ounces of milk, was taken for four months. At that time 10 ounces of milk were withdrawn from the diet (reducing the protein to 43.48 grams and this reduced diet was taken for six weeks. At the end of this period a steady fall in weight and increased fatigue were observed. After a return to the basal diet, lasting three months, another diet was substituted in which the protein was reduced to 41.80 grams by deducting meat and cake. After several weeks no loss of weight or fatigue were noticed by the subject. A further period on the reduced milk diet confirmed the experience of the first period. From this study it appear that 21 grams of milk protein in an otherwise adequate diet is sufficient to maintain general health even though the total protein has been reduced to 60.65 grams daily. "The protein of milk appears to be of more value for purposes of nutrition than the protein of meat."

In conclusion Dr. Mann stresses the fact that commercial pasteurized milk was used exclusively and was not especially selected for the experiment. He states further that he knows of "no evidence in support of the contention that the nutritive value of milk, as a whole, or of its vitamins or of its protein, is damaged by pasteurization to an appreciable degree. . . . No milk is really safe that has not been pasteurized. The best milk is that which comes from a tuberculin-tested herd and which is subsequently pasteurized by the low-temperature process."

Further Observations on the "Digestibility" of Common Foodstuffs as Determined by Radiography. W. C. D. MAILE AND K. J. L. SCOTT. Lancet, *228*, p. 1500, June 29, 1935.

The "digestibility" of raw whole and skimmed milk, whole and skimmed boiled milk, peptonized, citrated and alkaline milks, and milk with Robinson's patent barley, raw and boiled, has been studied. Of these variously treated milks, boiling alone reduced the time the milk remained in the stomach, from an average period of over three hours to three hours or under. Childrens' stomachs emptied faster than did those of adults.

Sugar taken with water leaves the stomach in considerably less time than does sugar alone, the actual emptying time depending upon the amount of water taken. In children a longer time is required for sugar to leave the stomach than for adults. These observations should be of value in the treatment of acidosis and hypoglycemia.

The emptying times were determined by mixing half an ounce of barium with the different foods studied, followed by frequent X-ray screening.

Electrokinetics in Relation to Dairy Phenomena. G. C. NORTH AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE *18*, 1, p. 21, Jan., 1935.

The streaming potential method was adapted to measure the zeta-potential at the fat-serum interface of milk. The central chamber of a special vessel had end-walls of platinum with a pin-hole in each. These platinum walls served to retain the fat and also served as electrodes. With a needle in place, through the pin-holes of the two electrodes, the central chamber of the vessel was filled with fluid milk fat. This was then chilled, and the needle was withdrawn, thereby leaving a capillary opening through the solidified milk fat. The capillary was filled with the milk serum in question and allowed to stand for 15 minutes to allow for adsorption. The diluted serum (1 to 10,000) was then streamed through this capillary under an observed pressure, and the potential difference between the two electrodes was measured with the aid of a Compton electrometer, used as the null point instrument. Conductivity measurements were made under the conditions of the test. The results were expressed as $H.K_s/P$, since the other terms involved in the zeta-poten-

tial calculation by this method were not determined, but were considered essentially constant.

The potential at the fat-milk serum interface is normally negative but its magnitude varies considerably when milks from individual cows were examined. As the pH of the serum is lowered the potential decreases; the isoelectric point was at pH 4.3; at still lower pH the potential was positive. The potential increased markedly as the temperature of measurement was increased. Chlorides of potassium, calcium, iron (ferric), and thorium lowered the potential, except that the potassium chloride in small concentrations showed a slight increase, but a decrease in higher concentration. Thorium chloride actually made the potential positive. Sodium citrate and di-sodium phosphate increased the negative potential, the citrate being the more effective.

The Action of Milk Fat as a Foam Depressant. ABRAHAM LEVITON AND ALAN LEIGHTON, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. JOURNAL OF DAIRY SCIENCE *18*, 2, p. 105, Feb., 1935.

In the study of the method by which milk fat acts as a foam depressant, the foaming power was measured by uniformly agitating 20 cc. samples in graduated cylinders and measuring the volume of foam one minute after agitation has ceased. Procedures are described for the measurement of dynamic surface tension, and of an index of superficial viscosity.

The destructive action of milk fat on milk serum foam can neither be attributed to changes in the dynamic and static surface tension of the serum, nor to changes in superficial viscosity, nor to changes in the quantity of protein adsorbed at the air/serum interface. The analogy which exists between the existence of a rupture in a thin film, and the presence in it of a spreading substance is offered as an interpretation of the phenomenon observed.

Dietetic Deficiencies and Susceptibility to Infection with Special Reference to Children. H. M. M. MACKAY. Lancet, *229*, p. 1462, Dec. 29, 1934.

While the spectacular results observed from dietary deficiency in times of extreme famine are not frequently seen, there are widespread and serious conditions arising from partial deficiencies which occur in the poorer sections of many cities. The effect of dietary deficiency on the incidence of disease has been observed by many. The author discusses this relationship, particularly as it applies to susceptibility to respiratory infections in children resulting from lack of vitamin D and iron. It is pointed out that many cases are the result of deficiency in several factors, as shown by the fact that the addition of one missing vitamin or other elements brings about only partial improvement.

However, when milk is added to the diet, a general improvement is observed which does not result when other foods are added, beneficial though they may be up to a certain point.

Gastric Digestion of Raw and Boiled Milk in Infants. J. G. OGILVIE AND O. D. PEDEN. Lancet, July 14, p. 76, 1934.

A comparative study of peptic activity in 24 infants receiving raw and boiled milk indicates that there is no significant difference in the gastric digestion of these two forms of milk.

A Study of the Salting of Milk by Determination of the Ratio Phosphorus-chlorine. R. VIVARIO AND C. STAINIER, University of Leige. Le Lait; *3*, p. 1073, 1933.

The authors find that the method advocated by Mlle. Sarran is not exact. The variation in the phosphorus content of milk does not follow the change in sodium chloride. A deficiency of lactose leads ordinarily to a dimunition in phosphorus. A decrease in the phosphorus is counter balanced by an increase in chlorides. The milk phosphorus is counterbalanced by an increase in chlorides. The milk must be isotonic with blood and therefore when one element decreases some other element must increase. Curves are given showing the change in sodium chlorides and phosphorus throughout a lactation period. As phosphorus decreases sodium chloride increases. Therefore, without a history of the milk absolute detection of added salt is impossible.

The Influence of Fluorine Ingestion upon the Nutritional Qualities of Milk. P. H. PHILLIPS, E. B. HART AND G. BOHSTEDT. Dept. of Chem., Dept. of Animal Husb., Univ. of Wisconsin, Madison. J. Biol. Chem. *105*: p. 123, 1934.

Small quantities of fluorine in the diet of humans or the feed of animals causes defective teeth formation. To what extent the nutritional value of the milk was affected by different levels of fluorine intake by the animals was the study undertaken. It was found difficult to influence the fluorine content of milk by dietary means and that the storage of fluorine was not proportional to the total fluorine intake. Apparently a mechanism of elimination operates beyond certain threshold limits. Fluorine determination of milk from cows receiving no added fluorine to their rations and from those receiving added sources of fluorine were not widely different with respect to fluorine content, The range of values for the amount of fluorine in normal milk was 0.05–0.25 mg. per litre (Av. 0.138 mg.). From 4.5 to 132 micrograms of fluorine per rat per day produced no detectable toxicosis nor did they produce any physiological stimulation.

Public Control of the Vitamin D Potency of Vitamin D Milk. CLARENCE A. SMITH. Tech. Director, Dry Yeast Dept., Standard Brands, Inc. Milk Dealer, *23*, 10, p. 38, July, 1934.

The author points out that the three present methods of producing vitamin D milk all have inherent control features. Few new products have been introduced on the market supported by so large an amount of thorough scientific research as has vitamin D milk.

Irradiated milk is subject to instrumental control which, although not absolute, is usually effective. Milk fortified by the addition of vitamin D concentrate is subject to control of the potency of the concentrate and of the amount added to the milk. The feeding of irradited yeast to cattle to produce vitamin D milk is controlled through the vitamin D content and the amount of the irradiated yeast. The factors which affect the transfer of potency from the yeast to the milk have been established.

The problems of the control officials are therefore simplified, since the product has already been subjected to scientific control measures. Analysis of milk, however, for vitamin D potency is time consuming and expensive, a single test costing from $25.00 to $50.00. Biological tests requiring the use of living animals are necessary. When samples are taken and tests made by control officials, without the prior knowledge of the producer, two or three tests yearly should be sufficient to establish effective control.

Minimum standards of potency must be established. Scientific evidence to date indicates that 55 to 60 Steenbock units per quart is a suitable minimum requirement for vitamin D milk produced by yeast feeding and for irradiated milk. The minimum potency of milk fortified by a concentrate has not been set at present, but the newly adopted USPX unit seems to be the best measurement at present. One Steenbock unit equals 2.7 USPX units.

Try the Milk Treatment for Intestinal Parasites. JAMES A. TOBEY, The Borden Company, New York City. The Milk Dealer, *23*, 10, p. 35, July, 1934.

Ascaris lumbricoides is the common round worm which occasionally inhabits the human intestinal tract. The author recommends that people afflicted with this worm, and other parasites, should drink plenty of milk each day.

These parasites are primarily vegetarians, thriving on vegetables and cereals, the high starch content of which provides the best food for them. The factor in foods of animal origin that discomforts these worms is the protein particularly the casein in milk.

Investigations with laboratory animals and actual experience with afflicted persons have demonstrated the beneficial effect of milk in the elimination of the various intestinal parasites.

Zoologists have pointed out that there are 85 different species of worms that may act as parasites in our system, as well as 25 different protozoa, and a few other species. Dogs, cats and other animals are also afflicted with parasites of various types, and they, like humans, benefit from high protein diets, especially those containing plenty of milk.

The Transmission of Vitamin A from Parents to Young in Mammals. II. The Carotene and Vitamin A Content of Cow's Colostrum. WILLIAM JOHN DANN, University of Cambridge, England. Biochem. J. *27*: 6, p. 1998, 1933.

The growth-promoting, anti-infective vitamin—A— is closely related to the yellow pigment (carotene) content. A study of the colostrum and milk from each of 14 cows showed that there may be from 10 to 100 times as much vitamin A in colostrum as in the later milk, independent of the season. The importance of colostrum milk for the calf is demonstrated by the fact that on the first day of life the calf receives supplies of vitamin A greater than the later milk could give in 20 to 50 days.

Feeding Experiments Show Importance of Vitamin A Content of Milk. O. E. REED, Bureau of Dairy Industry, Washington, D. C. Certified Milk, *9*, 93, p. 7, 1934.

Experimental work with dairy herds of the Bureau of Dairy Industry shows that cows fed on a ration adequate in every respect except vitamin A, produce milk deficient in this vitamin. The cows on this experiment have never given birth to normal calves. Over 75 per cent of these calves have been born prematurely, although the herd was free from infectious abortion. Over half of them were born dead, others were blind at birth and the rest so weak that they survived only a few days. Milk from these cows fed to normal calves resulted in death of all the calves, usually from pneumonia. Other calves lived when fed the same ration with the addition of cod liver oil or cream as a source of vitamin A. The butter fat from the milk produced by these cows was nearly white and contained only 10 per cent as much yellow color as that from cows fed alfalfa hay.

A Study of the Action of the Proteolytic Enzymes of Specific Organisms upon the Proteins of Milk and upon Gelatine. GEORGE SPITZER, E. H. PARFITT AND W. F. EPPLE, Purdue Univ., Agr. Exp. Sta., Lafayette, Indiana. Purdue Agr. Exp. Sta. Bull. No. 385, Sept., 1933.

The object of this study was to determine the proteolytic action of the enzymes of some of the typical types of microorganisms met with in the dairy industry. The proteolytic enzymes of thirty microorganisms and associated types and combinations were studied.

Secretion of Certain Constituents of Milk—Vitamin D. C. N. Frey, R. F. Light, and L. T. Wilson. Certified Milk, *9*, 93, p. 6 and 94, p. 10, 1934.

Four cows, two having an average daily production of 25 quarts, and two giving 11.5 quarts per day were milked at 12 hour intervals. These cows were milked 6 hours after the previous milking and again at the regular milking time. The high producing cows secreted 61.5 per cent of the 12 hour production during the first 6 hours, whereas the low producers secreted 54.5 per cent. This is of importance in regulating the time of feeding irradiated yeast to fortify the vitamin D content of cow's milk. Assays were made of the vitamin D content of the blood and milk of a cow fed irradiated yeast. The results showed that 70 per cent of the vitamin D fed the cow was absorbed in the blood stream. This absorption into the blood stream is greatest during the first and second hour after feeding. The rate of disappearance of this vitamin D from the blood is too fast to be accounted for by excretion in the milk or in the feces. The secretion of vitamin D in the milk runs nearly parallel to the level of vitamin D in the blood.

MISCELLANEOUS

Immunization Experiments on Calves with BCG. A. Stanley Griffith, J. Basil Buxton and R. E. Glover. Lancet, *228*, p. 451, Feb. 23, 1935.

Thirteen calves vaccinated intravenously with single doses of BCG at intervals of six, nine and twelve months after the first protective injection were given virulent bovine tubercle bacilli orally to test their resistance. Unimmunized calves were given equal doses of the bovine culture and were studied as controls.

The controls calves, killed 84 to 158 days after being given the test dose, all showed tuberculosis of the glands of the alimentary tract and two showed more generalized tuberculosis.

Of the revaccinated calves eight of the thirteen were free from tuberculosis, four showed encapsulated lesions, and one showed moderate tuberculosis.

The authors conclude that intravenous injections of BCG confer complete immunity to tuberculosis in calves for a variable length of time up to more than a year. Revaccination gave complete immunity in a much smaller number of calves. However, the number of animals studied is too small for definite conclusions.

Experiments on the Purification of Creamery and Packing-House Wastes. Max Levine, Engineering Experiment Station, Iowa State College, Ames, Iowa. Amer. Jour. Pub. Health, *25*, 2, p. 171, 1935.

This article deals principally with the purification of packing-house wastes.

On Bacterial Enzymes. W. GRIMMER AND J. RODENKIRCHEN, Dairy Institute, University of Königsberg, Germany. Milchw. Forsch. *17*, 1–2, p. 65, Feb., 1935.

It was found that, while some bacteria (species of Micrococcus, Sarcina, spore-forming and non-spore-forming rods studied, a species of Saccharomyces, and a species of Torula), formed as much or more catalase under anaerobic than under aerobic conditions, there were other bacteria which produced much less or none at all under anaerobiosis.

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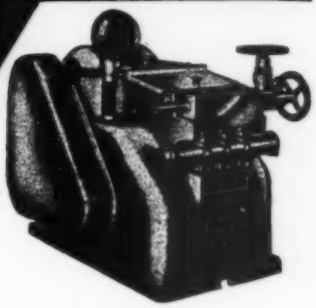

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